ARCHIVES

OF

USEFUL KNOWLEDGE.

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ACCOUNT OF THE NEW YORK ACCELERATING WHEEL-HEAD, FOR SPINNING WOOL.

(With a plate.)

Marcellus, November 14th, 1810.

SIR,

WITH respect, we acknowledge the favour of your letter, and embrace the liberty presented of communicating to you, and through your Archives, to the public, a more perfect knowledge of our improvement of spinning-wheels.

Mr. Miner, the patentee and inventor, in November, 1805, obtained a patent for a double-geered great wheel, also for a horizontal little wheel: the accelerating wheel was in that model placed in an intermediate situation. For three years he had not the ability to introduce with advantage his improvement; during which time he remitted not in his exertions to make it more worthy of notice, and it has perhaps undergone every possible change of relative proportion and position, which a mechanical genius could suggest, until it assumed its present form; from which we believe no deviation can be made to advantage. Our reasons for placing the wheel over the spindle, rather than in an intermediate situation, are obvious; it now serves as a friction-wheel to the spindle, which driven rapidly in the little band,

scarcely feels the ears, while the pivots above, being of neatly turned steel, and running in lignumvitæ, or hemlock-knot,* are subject to very little friction. Those hard, gummy substances, we prefer much to brass, or any kind of metal, both on account of neatness and durability.

In the beginning of 1809, Mr. Miner's mechanical abilities began to attract the notice of some speculative minds; a co-partnership was formed, and a small factory built under his superintendence, in which about 20 hands are employed:—we now make those heads at the rate of six or nine thousand per year.

We obtained a new patent last April, and perhaps the greatest proof of the utility of our improvement is, that there is scarcely a town in the New England states, where attempts have not been made to counterfeit our wheel-head; and when offered in the most tortured and deformed shapes, are bought with avidity.

Mr. Miner has made several attempts to apply this accelerator to a little wheel, and is as often led to contemplate a radical change in that useful machine. He has made it much his study, but no important change has yet been matured; perhaps that machine when neatly made, exactly balanced, the pivots neatly polished, of fine steel, and running on lignumvitæ, is complete in its present form.

A thorough conviction that our wheel-heads would be an imposition on the public, were they not faithfully and accurately executed in every part, has induced us to bestow much pains in making them. The spindle must be exactly round, and straight; and that they may the better keep so, are made of cast steel; the revolving parts are exactly balanced with lead; any defect in either, or knot in the band, will soon be discovered, and produce a disagreeable jumbling.

Carding machines in our country were, when first introduced, thought to injure the wool: that complaint ceases with the old wheel-heads. Hence it appears that machine-rolls being much

* A hemlock-knot has been found to endure the friction of a mill-gudgeon, three times as long as cast iron.

easier drawn out than those carded by hand, did not receive a sufficient twist, which difficulty is now obviated.

Were we skilled in drawing, our vanity might induce us to send to you a plan of our shop, which partakes as much of originality as any thing perhaps in the United States. We have ten lathes, a machine for boring, a cross-cut saw and circular saw, all operating separately or together, by one water-wheel; which lying beneath the lower floor, the rooms are dry in the lower story.

Mr. Miner's last improvement has been upon a lathe for turning spindles more expeditiously: the "rest" travels alternately from right to left, and from left to right, by the operation of the wheel, without the least manual assistance. The same principle might be applied to a rope ferry, where a water-wheel could act, so that the boat should constantly ply from shore to shore without the assistance of a ferryman.

With sentiments of much respect,
We subscribe,

MINER, DEMMING, PIERCE, & CO.
By D. DEMMING.

Dr. JAMES MEASE.

P. S. Our wheel-heads are in common use throughout the county of Onondaga, where they have been known longest, and a more perfect use of them thereby gained: they are allowed by all to save *one-third* of labour in spinning wool; *half* in spinning worsted, and *absolutely necessary* in spinning Merino wool: great use is also made of them in spinning cotton and tow. Their motion was at first thought too rapid for tow, but a little practice surmounts that difficulty, and nearly double the quantity of that article is now spun by old practitioners, in a day.

The gain of velocity in the spindle, by the addition of the accelerating wheel, is as 19 to 9, or a little more than double.

Editor.

IMPROVED SHEEP-SHEARS.

By captain JOHN MILLER, *of the British navy.*

From the Trans. Soc. Arts, London. Vol. 25.

SIR,

BEING present at the shearing of some sheep in July, I observed that they were frequently cut, and sometimes pieces of their skin and flesh were cut entirely off, which gives not only much pain to the animal, but if cut severely, may be attended with loss to the owner: I have, therefore, contrived a plate of iron to screw to one of the blades of the shears. This plate must be unscrewed and taken off, when the shears require sharpening. I have seen a sheep sheared with the shears I send, and the farmer who used them said, they made as good work as those in general use; and it appeared to every one present, that it was hardly possible to cut the sheep in using them. The experiment was made at a farm called New-Park, near Axminster, belonging to Mr. John Harvey Pierce, who esteemed it as a useful invention for the purpose intended. I therefore take the present opportunity of communicating this to the society, trusting that through their patronage of useful contrivances, it will sooner be introduced to the notice of the public; and if it should prove of utility, I shall feel much gratified.

Signed,

JOHN MILLER,
Post-captain royal navy.

New-Park, Axminster, Devon,
August 13, 1803.

Engravings are given, 1st, of the shears with the plate on, and in the proper position for shearing with the right hand. In this case, the plate must be screwed upon that blade which is toward the left, when the shears are held open in the right hand.

2d, of a pair of shears requisite for a left-handed person. In this case, the plate must be screwed upon the blade which is toward the right, when held as before. In both cases, the plate is

to be screwed on the under side of the blades; and the unarmed blade inserted into the wool. Three screws are necessary to fix the plate: these screws must be counter sunk, and either not go through, or be filed so as to prevent their taking the edge of the other blade in closing the shears. This plate is to be about the 20th part of an inch thick, and must be unscrewed and taken off when the shears require to be sharpened; and as the blade of the shears wears by frequent sharpening, the edge of this plate must also be reduced so as always to be kept in a line with the edge of the shear;* for if it projected beyond it, the wool would receive a sloping direction, and be more difficult to cut.

The editor having failed on two occasions, to obtain the improved shears from London, last year made an attempt to have the plate added to a pair of common shears, by a Philadelphia cutler, and was happy in finding that it succeeded fully; the shearer was highly pleased with them, and upwards of one hundred sheep (Merinos and others,) were shorn, without any injury having been done to the skin. The edges were exactly even. These shears were presented to an agricultural correspondent in the autumn, and another pair ordered the last spring: but they did not answer the intended purpose, the skin being cut by them, as readily as by common shears. This effect was attributed to the blade not being of the requisite thickness, and hence the edge of the shears on which the plate was fixed, not being raised sufficiently high, a slight pressure forced the skin up between the edges of the shears, and caused it to be cut. The edge of the plate also, projected a little beyond the shear. Another pair having

* In captain Miller's first communication, dated August, 1803, the edge of the plate is directed to project beyond the edge of the shear, so as just to be visible when the shears are open and held in the position for shearing, that is, the plate downward laid on the sheep; but in the explanation accompanying the engraving, which is dated June, 1805, it is directed to make the edges of both plate and shears even, for the reason given. The former direction is therefore omitted in captain Miller's letter. It is evident that the edges should be even. *Editor.*

been ordered, with the plate set about a line less than the tenth of an inch in the clear from the shear, answered the purpose completely, upon six Merinos. The skin was not cut, even when a degree of pressure greater than ordinary, was used. It is questionable whether a plate only one-twentieth of an inch thick, and screwed close on the shear, as advised by Mr. Miller, would answer with Merinos, the closeness of whose fleece requires a degree of pressure with the shears, to make good work, greater than with ordinary open-woolled sheep.

Mr. Rose, cutler, South Seventh-street, Philadelphia, adds the plates to shears.

IRISH MODE OF
RAISING AND ROTTING FLAX.*

By S. M. Stephenson, M. D. *of Belfast.*

IN a history of the Linen Manufactory, our intention is to relate the different operations, which we know have been, and are performed in the province of Ulster, upon the *Linum* Usitatissimum Lin.

Most of our flax-seed is imported from Riga, the Low Countries, (Flanders) and America. Riga produces the greatest quantity of seed. The casks are often badly finished, and the seed sometimes damaged, and often too long kept. Memel seed produces short flax, and is now despised.

The Dutch is a large, dark coloured seed, flat, and shrivelled, like unripe seed hastily dried, yet it sells as high as Riga, and higher than American. It cannot be safely kept through winter, so as to be sown the following spring. Probably the damp air of the Low Countries, and unripe seed, are the causes.

The American seed is smaller, and rounder than the Dutch; the colour lighter, the skin smooth. The preference of the Dutch seed, is contrary to our experience of the advantage of

* From the Transact. Belfast Literary Society.

changing the seed of the grain to a kind of soil different from that in which it was produced. The soil of America differs more from the soil of Ireland, than the soil of the Low Countries; yet the Dutch seed is preferred to the American, from a supposition that it produces larger and longer stalks, and a greater quantity of flax.

The annual average sale of flax-seed in Belfast, Newry, and Londonderry, amounts to 25,000 hogsheads.

Riga and Dutch seeds are sold at the same rate by the wholesale merchants; New York, Philadelphia, and Boston, at the same rate: New York and Boston are preferred by farmers to Philadelphia.

When flax is nearly ripe, a disease called firing, often attacks it. It appears upon the bark like mildew upon the stalks of wheat, and like parasitical plants, injures the stems which supports it. The fungus adheres so closely to the rind, as to elude the operations of watering, switching, hackling, spinning, boiling, weaving, and often of the old method of bleaching: pulling the flax is the only remedy yet discovered. Most of it may be removed by scraping and brushing at the time of hackling, or before hackling, by an old instrument, the *clove;* it resembles curling-tongs upon a large scale; the cylindrical side, the tongue, is of wood, the concave side of iron, the sharp edges of which scrape the flax drawn between it and the tongue. The new method of bleaching removes every appearance of sprit.

When flax stands till the seed is ripe, the fibres are coarse, and not easily divided by the dressers; but the quantity is greater, and the produce of an acre sells for more than if it were fine.

Flax leaves land in a good state for wheat. Clover-seed is sown with great advantage with the flax, because the flax is early off the ground, and the land is made looser, and the clover moulded by pulling the flax.* If the clover is luxuriant, the ground will be left in excellent condition for wheat or flax, if sowed with one furrow on the clover lay.

* The Editor can confirm this; the practice is common in Pennsylvania.

Potatoes, flax, clover, wheat, is a very proper course of crops upon *clay* ground; oats in place of wheat on light land.

Flax-seed bright in colour, heavy, free from seeds of weeds, and which when bruised, appears fresh, tastes sweet, and not fusty, should be chosen.

This useful plant delights most in a deep open loam, kept some years in pasture; when ploughed only once, it will be free of weeds, and produce the strongest and best flax. Land which is free and open, may be sown with potatoes with harrowing only; if inclined to clay, it should be ploughed, and well harrowed before sowing. Flax should not be sown on rank, stiff clay, nor on dry ground, nor in small fields, surrounded with high trees or high hedges: as these, by keeping it wet, cause it to lodge, and the drops from the trees prevent its arriving at maturity.

Flax ground, deep and dry, should be laid flat; because if it is in ridge and furrow, it will produce stalks unequal in length. If the ground be thin and flat, the seed must be sown upon the land laid up in ridges: the flax on the ridge must be first pulled, and that in the furrow sometime after. The long and short stalks should be kept separate, else the short may be lost in dressing.

The quantity of seed sown upon an acre differs with the soil, and the views of the farmer. If seed is sown thick upon a very rich soil, the flax will lodge in wet weather. If a great quantity of flax, or of seed is desired, it is sown thin. American seed being less than the Dutch, requires more ground. Three Winchester bushels are generally sown upon an acre Irish measure.

Our time of sowing is usually in April. If the land is free, or brought to a fine mould, rolling causes the ground to support the tender stalks better, and prevents lodging. Rolling, without harrowing is safest and best for flax and clover-seed.

Seeding weeds should be carefully pulled, and old weeds with large roots cut, when the flax is three or four inches high.

When the flower has fallen, and the farmer examines the crop, he will find, that some parts of the ground have produced long

coarse flax, and short coarse flax, with many branches, and full of bolls: these varieties he saves for seed. He will likewise find some long and slender, some short and slender, with a few bolls: these he will pull when the stalks turn yellow, before the leaves fall, or the bolls turn hard, and will carefully keep each sort separate. If any of it has been lodged by rain or other causes. he can save it by immediate pulling only. The coarse, which is intended for seed, must stand till the bolls are sharp pointed, the stalks fully ripe, and managed as before-mentioned.

That the process of watering flax may be regular and safe, ponds should be sunk in clay ground, four feet deep, the length of them proportioned to the quantity of flax watered. If clay ground, or such as can hold water, is inconvenient, they must be lined with clay, in such a situation that a stream of fresh pure water may be turned into them; neither floods nor mineral water should be permitted to enter them, nor should they be under the shade of trees; which occasion the temperature to vary by their uncertain shade: trees with astringent bark or leaves, in storm and rain, may also stain the flax.

Flax is put into the pond in a slanting direction, with the top downwards; it is then entirely covered with sods, to prevent the sun's rays from penetrating it under the water, and hastening the fermentation in one part more than another. If the sods do not sufficiently sink it, logs of wood or stones may be laid upon the sods; but it should not be pressed to the bottom.

Coarse flax requires shorter time in the water than fine, and ripe a longer time than unripe; these should be carefully kept separate, and put into different parts of the pond, and in such situation that they be conveniently taken out, without disturbing that which should remain longer.* When the mucilaginous membranes connecting the fibres of the flax are destroyed, and

* In July and August, eight days may be sufficient; in October, sixteen days may be too little. Mr. John Christy, a great flax grower, in the county of Down, says, that he permits ripe flax to remain six days in water; but if pulled green and watered in autumn, he considers four days sufficient. He prefers giving it more time on the grass; he turns the flax after it has lain about half

the fibres connecting them to the boon or bone, are weakened by the putrifactive process, the bark separates from the ligneous body, and the fibres appear distinct. This period is ascertained by drawing out from time to time, breaking and rubbing a small portion of it between the fingers. If it is brittle, and breaks with little effort, a longer immersion might extend the decomposition to the fibrous texture, which at this time is most delicate; wherefore it is sometimes taken out of the pond before the mucilaginous membranes are sufficiently weakened, and the process finished by laying it on the edge of the pond, as heat is soon generated in such a heap: the greatest attention is bestowed upon this position. After the flax is taken out, the pond is cleaned, and pure water let in, before fresh flax is put into it. The water is poisonous to fishes, and the air is infected.

This process is expeditiously finished by boiling the stalks a few hours in pure water; more speedily by boiling it in caustic mineral ley. This method could not be practised upon a large scale. An immense quantity of flax might be subjected to this process, by suspending it upon wicker work, supported by frames in a steam-tight chamber, with a boiler attached to it by a tube, for conducting into this room the steam of a weak alkaline ley. In this process the artist can every moment attend to the progress of the operation, and stop it at its proper period.*

For grassing flax, dry lay land free of weeds is preferred. If the grass springs through the flax before it is perfectly grassed, turning is the only remedy.

The first row of flax is spread on the east side of the field, with the tops to the west, the roots of the second row are laid a few inches over the tops of the first, the roots of the third on the tops of the second; in this manner the whole is spread, which prevents the flax from being tossed by the winds, and has the effect of watering the tops better.

the time on the grass; and if a calm day is chosen for doing it, and the end of one row made to overlap the other, it will soon take hold of the grass, and run little or no risk of being tossed by the winds.

* O'Reilly on Bleaching.

When sufficiently grassed, the filaments easily part from the bone, which becomes white and brittle. Experience teaches the most proper period for lifting it: in this operation, it is of great importance to keep the top ends together and even.

Preparation of the ground.

In Ulster, the farmer fallows old lay the preceding summer: choosing land which has produced a good crop of potatoes or wheat, and manures richly; ploughs in October, lays it down in ridges nine feet broad, with alleys two feet broad, and ploughs it immediately before sowing: when the ground is well harrowed, it is sown with double the quantity of American seed, and rolled.

Strong forked stakes are then fixed in each border, three feet distant, twelve inches above the surface: a pole is laid across the ridge in each fork: brushwood or rods are laid across the poles: these shelter and support the tender plant.

It is pulled soon after the flower-leaf falls, before the stalks turn yellow, and laid upon the brushwood to dry: when dry, the balls are struck off, it is tied up in beets, with dried rushes, each of such a size as can be grasped with a man's hands: and made up into bundles, with the tops of each beet overlapping the tops of the other, opposite it, five or six inches, the roots outwards: each bundle is wrapped in straw, and tied in the middle, and at each end. Stakes with hooks, like those used by gardeners, for keeping down layers, are driven into the sides of the pond about five or six feet asunder, level with the surface of the water. The bundles are then thrown into the water, about a foot distant from each other, and pressed down by poles across the pond: those poles must not have an astringent bark. The intention in these operations is the production of fine white filaments without stains: he therefore causes a small stream of pure water to pass through the pond, during the time of steeping, and never allows the flax to touch the sides or bottom of the pond.

In the next number, the machines and utensils employed in finishing linen, shall be described.

MEMOIR ON THE MORDANTS EMPLOYED IN DYEING.

By Messrs. Thenard and Roard.

Read to the class of Physical and Mathematical Sciences of the Institute.

Translated for the "Archives."

(Continued from p. 59.)

On the aluming of animal and vegetable matters, with the acetate of alumine.

Wool, silk, cotton, and flax, in the different states, in which these substances are employed in dyeing, have been treated with the acetate of alumine, which has completely combined with them. But as in the exposure to the air, in a temperature a little elevated, the mordant always loses a small quantity of acid, it follows that the combination formed upon the stuff is an acetate, with excess of base; for this reason, in treating it with boiling water, it is converted into an acid acetate of alumine, which is dissolved, and an alumine which cannot be extracted by washings.

CHAPTER THE THIRD.

ARTICLE I.

On the action of acidulous tartrite of potash upon wool.

Wool, well scoured, has been treated, as in the preceding experiments, with very pure creme of tartar, free from lime, and formed directly with acid of tartar and potash. This wool has been washed many times, and the last washing did not contain any more of the principles which had been combined with it. The evaporation of this bath gave us a creme of tartar pure and crystallized in the proportion of a third part of that employed, and moreover some neutral tartrite of potash. The washings were very acid; we extracted from it a small quantity of creme of tartar, and a combination, extremely acid, formed with the acid of tartar and wool. These facts might have been sufficient to explain the phenomena which take place in the aluming of

wool with alum and tartar, since we know already by the experiments of Mr. Bethollet, that these two salts are not decomposed, and that we have demonstrated, that the wool is combined entirely with the alum, and that it acts upon the creme of tartar, in taking from it the tartarous acid, with which it unites in a most intimate manner: but in order to have, with respect to that, a full proof, we repeated this experiment, although long, by following the method marked out by the preceding chapters.

ARTICLE II.

Before treating wool with alum and creme of tartar, we made some experiments on the reciprocal action of those two salts. We have ascertained that water does not hold in solution, at the temperature of 12° or 14°, more than $\frac{1}{130}$ of creme of tartar, that boiling water dissolves $\frac{1}{30}$ of its weight, and that a mixture of equal parts of alum and creme of tartar, is dissolved in $\frac{3}{5}$ of its quantity of water; that these two salts would have required to be dissolved by themselves, at the same temperature. These results do not differ from those already obtained by M. Bertholet, who has demonstrated that alum has the property to augment the solubility of the creme of tartar.

If we alum wool in the ordinary proportions, which are $\frac{1}{4}$ alum, and $\frac{1}{16}$ of creme of tartar of the weight of stuff, all these matters being perfectly pure, we will obtain from the alum-bath, sufficiently evaporated, some alum and creme of tartar, and a residue difficultly crystallizable, composed of the tartarite of potash and of animal matter. The washings of this wool will give some alum, and a very small quantity of creme of tartar, and a combination extremely acid, formed of much tartarous acid, of alum, and animal matter.

These observations do away all uncertainty upon many practical facts, which hitherto offered to the dyer only some very vague calculations, and point out to him in a precise manner, the steps he ought to follow in the application of these mordants, according to the nature of the colours which he desires to obtain. In fact, in aluming with alum and tartar, we combine with wool,

alum and much tartarous acid; we must only use these two salts in cases where the colour is susceptible of being augmented and rendered more lively by the acids, as is the case with cochineal, madder, and kermes; whereas we ought not to alume, except with alum, the wool intended to be dyed with woad,—wood of India, Brazil wood, of which the colours are easily altered or destroyed by acids.

Among all the animal and vegetable substances, we chose only wool, to treat with alum, and with alum and tartar, because it is solely with that material that these mordants are employed in dyeing.

ARTICLE III.

On the action of acids, and of some salts employed upon wool as mordants.

Although all the attempts that have been hitherto made, to discover a substitute for alum, have not succeeded, we have nevertheless treated wool with a great variety of substances, less however to find out the most advantageous mordants, than to ascertain the action of some animal matters upon them, which are very soluble, and that possess great strength.

We boiled wool for two hours in water, with small quantities of sulphuric, nitric, muriatic, and tartarous acids. All these specimens of wool, but principally those combined with the sulphuric acid, gave, with cochineal and madder, colours at least as deep as those obtained from stuffs alumed with alum and tartar. After that, we cannot doubt that these acids might offer in that case great advantages, if they caused the felting of the wool. But of all the mordants of which we have tried the action, there is none which has given, (notwithstanding the opinion of Mr. Haussman) colours so vivid as those obtained by the intervention of the acid tartarite of alumine. The use of this salt, might be in several instances preferable to tartar and to alum, on account of the vivacity of the colours, if the price was not higher than that of the other two substances. In trying to determine with great care, all that relates to the nature and to the mode of combina-

tation of mordants with the stuffs, we have not forgotten the examination of some practical methods adopted a long time since in all the dye-shops; of which the most important is to know if the proportions of alum and tartar, the most generally employed, are in fact preferable to all others; if the time taken up by the process of aluming is sufficient to combine with the wools in a complete manner; and finally, if the method, which we believe very necessary, to leave them for some days in a cool place after the process of aluming, gives more advantageous results.

Equal parts of mordants, or half the weight of the stuffs, do not act better than $\frac{1}{4}$, but in reckoning from that proportion to $\frac{1}{20}$, the colours of cochineal, kermes, and madder, are weakened according to the diminution of these salts; whereas this effect operates inversely for the woad,—the wood of India and of Brazil, so that in those four last substances, the colouring appears so much more deep, as the wool has received less of the mordant. Wools alumed during two, four, six hours, has given to the dye different colours; thus it is useless to prolong the aluming beyond two hours. The relative experiments, immediately after the aluming, or a very long time after, have not presented to us, among them, any difference, except only that the wool alumed with alum alone, which on the wood gave us colours more deep, after having remained sometime in a cool place: which can only be attributed to the separation of the acid sulfate of potash, which has ran out with that part of the mordant not combined with the stuffs.

CHAPTER THE FOURTH.

ARTICLE I.

Of the Scarlet colour.

Scarlet is that brilliant and lively colour which is given to wool, in treating it with tartar, with cochineal, and the solution of very oxided tin. Before the discovery of this process, which is due entirely to Drebbel, they also called scarlet the colours obtained upon woollen stuffs, by kermes or cochineal, and for which they employ alum and tartar. The processes for obtain-

ing that colour, are known long since among the workmen, however they have not as yet made any theoretical researches upon the phenomena, which take place in the treatment of the solution of tin with creme of tartar and with cochineal. Dr. Bancroft, who has experimented with much success upon dyeing, has endeavoured it is true, to show what passes in the formation of that colour, but as his opinion does not appear to us illustrated by any experiment, we ought not the less to look upon this question as being as little advanced as it was before the publication of his work. We propose in this fourth chapter, to determine the chemical nature of the combination formed upon wool by the cochineal, the tartar, and the solution of tin; and to make known the result of our researches upon scarlet.

ARTICLE I.

Examination of the precipitate formed by the solution of tin, and the acidulous tartrite of potash.

All the matters used in our experiments were perfectly pure, and we uniformly used glass vessels and distilled water.

Eighty grammes of acidulous tartrite of potash, dissolved in three kilogrammes, five hectogrammes of distilled water, were heated for two hours to 100° of the centigrade thermometer, with 125 grains of a solution of tin. The precipitate on being washed several times, and distilled in a retort and plunged in lime water, disengaged a very sensible quantity of carbonic acid. Proper reagents have indicated in other parts of this composition, the presence of much tin and muriatic acid. Thus the creme of tartar and solution of tin, are decomposed, and give a precipitate formed of the acid of tartar, and much muriatic acid and tin. The mother-water contained tartrite of potash, acidulous tartrite, very acid muriate of tin, and a quantity of precipitate, which is held in solution by excess of muriatic acid.

Wool, white and pure, treated with the ordinary proportions of a solution of tin, and of creme of tartar employed in the scarlet dye, having received many washings in boiling water, which have taken away all the substances combined with it; these

washings, united and evaporated, yielded the same principles, which we had already obtained from the precipitate formed by the solution of tin and creme of tartar.

We have discussed in these researches the action of cochineal, and we have ascertained that it did not make any difference from these results.

We have acquired by these means, the certainty that this fine scarlet colour is only caused by one combination, with the wool and the colouring matter, the acid of tartar, muriatic acid, and peroxide of tin. But we would greatly mistake, if in this operation, we were to regard as nothing the influence of a bath: for wool combined with mordants that we have just noted, and passed through the bath of cochineal, never takes there the scarlet shade, and cannot take it but by the action of this very acid bath, which in making yellow loses the impression of cochineal, which gives so much brilliancy to that colour. This last experiment, and some others, which we will detail at the close of this memoir, prove to us, that the wool, as we believed, does not take the impression of yellow in that operation, by the combination which it forms with the nitric acid, which is found in excess in the solution of tin; for this wool comes out perfectly white, from all the boilings and reddenings, to which it was submitted, when colouring matter has not been employed.

ARTICLE III.

Of the tartarites of tin, and some other metallic solutions.

The proofs which we have just given of the formation of scarlet, appear so evident, that we should not have thought to increase the number, if the importance of this question had not induced us to give a more extended view of this work.

We have experimented upon wool in the usual proportions for scarlet, with all the sulphates and muriats of antimony, of bismuth, of zinc, and of arsenic. Some of those solutions have given us very agreeable colours, but they differ sensibly from that which we wished to obtain.

We have been very fortunate in our researches upon the tarta-

rite of tin obtained from the tartarite of potash, and of soda, by the muriat of tin, very oxided. This salt dissolved in the muriatic acid, and employed in the boilings and in the reddenings destined for scarlet, have given us colours as deep and as lively as those obtained of creme of tartar and solution of tin. The tartarite of tin dissolved in an excess of its acid, produced also very good effects; however, as that way would be more costly than the ordinary process, it will be much preferable to adopt the solution of that salt in the muriatic acid. But before recommending the use of this mordant to the dyers, we propose to try it in the large way, to determine, in a very strict manner, the price and all the advantages.

ARTICLE IV.

Researches upon the scarlet colour, and the oxides of tin.

Scarlet, as we have already said, is obtained by treating wool with certain proportions of cochineal, of acidulous tartrite of potash in solution, and the very oxided solution of tin in two operations, called boilings and reddenings, the first of which lasts one hour and a half, and the second half an hour. The division of this operation in two parts is necessary to produce that colour which would be less deep, and more yellow, if they reunited all the matters at one time, to make them boil together during two hours. This fact is owing to the very acid state of the bath, which retains in solution a great part of the mordant and of the colouring matter. They would obtain, with respect to this a result entirely the reverse, in putting in the boiling with the wool all the mordants, and in reserving the cochineal solely for the red.

From the time that the Dutch scarlet was spread in France, they have experienced the very serious inconvenience to which it is exposed, of being easily affected by water, and of loosing its handsome colour, taking on a colour more or less crimson; but hitherto they had not endeavoured to ascertain the cause and extent of it.

Fine patterns of scarlet cloth, treated a great number of times

at 100°* in a mattress with distilled water, left successively in the water, a portion of their colour, and after that operation was finished, they had but a very slight flesh colour. The washings reunited and evaporated, were very acid, and contained besides the colouring and animal matter, some tartarous acid, some muriatic acid, and some oxide of tin.

Scarlet is then, as we have demonstrated, a combination slightly soluble, which by loosing in water, a small quantity of acid, changes its colour; and which by repeated washings, aided by the elevation of temperature, and by the mass of liquid, may be deprived of it, in the most complete manner.

It results from the foregoing experiments: 1. That in the aluming of all vegetable and animal substances, with alum, it is not the alumine which is combined with them, but certainly all the alum; and that when these matters have not been purified, the lime contained in them, causes the decomposition of a part of this mordant.

2. That all the alkaline and earthy bases, treated with solutions of alum, decompose it, and convert it into an acid sulphat of potash, and into an insoluble salt, less acid than the alum, which new washings can convert into pure alumine, into sulphat of potash, and into alum.

3. That acetate of alumine also combines completely with silk, wool, cotton, and thread; but that this composition slightly retaining the acetic acid, loses a portion of it by mere exposition to the air, and that it is transformed into acetic acid of alumine, which is discharged by the water, and into alumine, which remains upon the cloth.

4. That the alum and the tartar are not decomposed, but that the solubility of the latter is augmented by their mixture; and that in the alumings of wool by tartar, or by alum and tartar, the tartar alone is decomposed; that the tartarous acid and alum combine with them, and that the tartarite of potash remains in the bath.

* The centigrade thermometer is meant. *Editor.*

5. That the strongest acids have the property, in combining themselves with wool, to determine the fixation of the colouring matters, a property which is also possessed in a high degree, by the tartarous acid of alumine.

6. That the alum and tartar cannot be employed indifferently for all colours; and that their proportions depend upon the nature of the colouring matter: that the time of aluming cannot last more than two hours, and that its remaining in a moist place after the application of the mordants, appears to be useless, with a view to increase the intensity of the colours.

7. That the tartarite of tin much oxided, dissolved in muriatic acid, may be substituted in the dyeing of scarlet, for the creme of tartar, and the solution of tin.

8. Finally, that these researches may furnish successful applications in the combination of mordants with stuffs, and the improvement of many of our dyeing processes.

MEMOIR ON THE BEST METHOD OF DYEING CLOTHS AND STUFFS WITH SANTAL WOOD [RED SANDERS.]

By M. Vogleu.

From Crell's Chemical Annals, for 1790.

Translated for the "Archives."

THE method pursued by dyers, in the use of santal wood, is far from being advantageous. They generally employ an aqueous menstruum to extract the colouring matter, which never thoroughly produces the desired effect: and on this account it is impossible that stuffs by this process, can acquire a proper colour. Amongst a great number of experiments which I have made on this vegetable substance, called by botanists, *Ptero-carpus santalinus*, *santalum rubrum*, the following succeeded the best, and were repeated at least ten times.

FIRST EXPERIMENT.

I took some pieces of silk, linen, cotton, and woollen cloths,

used; and digested them for the space of six hours in a solution of tin in nitrous acid, and tempered by three parts of water; I then washed them three different times in distilled water, and afterwards hung them to dry, and then soaked the half of each for an hour, in the cold spiritous liquor described in the sixth experiment: the other half I digested in the tincture of santal wood, mixed with water, mentioned in the seventh experiment, which I boiled for a quarter of an hour. I then wrung these pieces of stuff, and having dried them in the shade, I found that they had acquired a very lively red colour.

SECOND EXPERIMENT.

I took two grains of alum, which I dissolved in two ounces of water, and while the solution was still warm, I digested in it for twelve hours, some pieces of linen, silk, cotton, and woollen cloth; after which I washed them three different times, in distilled water, then wrung them, and dried them in the shade as before. I then took a half of each of these pieces of stuff, and suffered them to digest for an hour in the spirituous tincture mentioned in the sixth experiment; and the other half in the aqueous tincture mentioned in the seventh experiment, which I boiled for half an hour. Those stuffs being then wrung, and dried in the shade, appeared to be of a most beautiful and brilliant scarlet colour.

THIRD EXPERIMENT.

In a solution of three grains of vitriol of copper, in twelve ounces of water, I soaked for twelve hours, some pieces of these different stuffs, and having wrung, and dried them as above, I took the half of each, and suffered them to digest for an hour in the spirituous liquor mentioned in the sixth experiment, and the other half in the aqueous liquor mentioned in the seventh experiment: having then made them go through the same operations as before, they appeared to be of a most beautiful crimson.

FOURTH EXPERIMENT.

Having digested the same stuffs for twelve hours, in a solution

made with three grains of white vitriol, in twelve ounces of water, and having treated them as before, I found that they had acquired a deep crimson colour.

FIFTH EXPERIMENT.

I dissolved three grains of martial vitriol in twelve ounces of water, and having repeated the same experiments on the like kind of stuffs, I found that they had acquired a beautiful deep violet colour, and sometimes a dark red. The dyes in which these stuffs were digested are prepared in the following manner:

SIXTH EXPERIMENT.

Take four grains of red santal wood reduced to a very fine powder, and dissolve it in twelve ounces of strong spirit, and expose it to a gentle heat. In the space of 48 hours, it will be found that the spirit* had extracted all the colouring part of the santal wood: but, while it is digesting, care must be taken from time to time, to shake the vessel which contains it. The dye prepared in this manner, may be employed, when cold, to dye stuffs, even without being filtered; for the stuffs digested in it for an hour or two, will be found to have extracted all the colouring matter. This dye does not loose its quality of dyeing, though kept for a considerable length of time; if it should happen that it has deposited its colouring part, or that it has been deprived of it, by putting cloth in it, a fresh quantity of the powder of santal wood may then be added.

SEVENTH EXPERIMENT.

Having diluted the spirituous tincture of santal wood with six or seven times the same quantity of water, I found that this addition of water did not prevent the effect of the dye, and by these means I obtained the aqueous liquor, in which I almost boiled all the before-mentioned pieces of stuffs, previously soaked; also the pieces of linen and cotton cloths, which had been soaked and

* The expression in the original is *aqua vitæ;* it is uncertain whether brandy or alcohol is meant: the dyer will of course, make his experiments cautiously at first. *Editor.*

steeped in glue water, and they acquired immediately a solid and lasting colour.

Stuffs or cloths must not be digested longer than 48 hours, in the spirituous liquor above-mentioned, and the liquor must be used quite fresh. It appears that spirits extract a yellow colouring matter, from red santal. When these stuffs are boiled in aqueous tincture, it will not be necessary first to separate it from the powder of the santal; and it will likewise be needless to wash the stuffs, because when they are dry, the powder may easily be removed by rubbing them. It may not be improper to mention that I have observed, that as soon as these stuffs were taken from the liquor, and squeezed, or wrung, digesting them for some minutes in a cold solution of twelve ounces of water, four grains of marine salt, and two grains of alum, was of the utmost service to them. Great care must be taken to wash them in cold water, after they have undergone the operation of digesting, in the manner last mentioned; the colour in this way becoming more solid and durable. In short, woollen, cotton, linen, and silk, dyed after this method, wonderfully resists the action of every kind of lye, whether soapy alkaline, or even acid. But in the open air, and exposed to the sun, linen and cotton are subject to loose a little of their splendour.

According to my observations, water alone and lyes, are not sufficient to extract all the colouring matter of the red santal wood; and stuffs dyed in such decoctions, acquire but a pale colour, which soon fades: spirit of wine is the only liquid hitherto found, that is capable of extracting thoroughly, the colouring part of santal wood, and communicating it afterwards to different substances.

The process here described, is indeed attended with considerable expense; but those who employ it, will be amply compensated by the superb colour it will give to various objects. Santal wood reduced to a fine powder, is preferable to that which is only bruised or pounded.

In order to be certain that the santal wood is not adulterated, it will be best for those who use it, to buy it whole, and to reduce it to powder themselves.

ON THE PROPER VARNISH FOR SILKS.

From the Tradesman, or Commercial Magazine.

"They only deserve the appellation of travellers, who are eager to make such researches as shew their love of nature, science, and the great objects which conduce to the comforts and ornaments of mankind." KETT.

BALLOONS are defective in the composition employed for the varnish, which, until lately, was incapable of rendering them completely and durably air-tight. It was, some time back, reported at Paris, that M. *Dutourny de Villiere*, had undertaken to construct a balloon so truly impermeable, that he would warrant the *duration* of it for several weeks in the air; and it is since known, that this desideratum of the art had been effected in the composition for the celebrated balloon of Messrs. *Vallet and Co.* first made in a certain degree subject to direction. M. *Bernard*, a French chymist, has made several, though unsuccessful experiments, in order to melt the elastic bottles, as may be seen in the 17th volume of the *Journal de Phisique*. M. *Faujas*, and others, made similar trials. The author of *Airopaidia*, and one of our adventurous British aeronauts, Mr. Baldwin, unacquainted with what had then been done in this matter, could not help remarking the striking properties of the *caoutchuc* in its present form, and that it would answer every intention of the best varnish, since it is compact, pliant, unadhesive, and unalterable by weather, if it could be dissolved, and afterwards made to recover its present unadhesive form, an art in which the East and West Indians are still our masters. He has, however, after expensive trials and combinations, been able to reduce it to a limpid liquor, as it may prove an useful ingredient for air-tight varnish. The secret he now discovers to the world, and it is merely this: take any quantity of the caoutchuc, as ten ounces avoirdupois, cut it it into small bits with a pair of scissors, put a strong iron ladle (such as painters, plumbers, or glaziers melt their lead in) over a common pit-coal or other fire; the fire must be gentle, glowing, and without smoke. When the ladle is hot, much below a red

heat, put a single bit into the ladle: if a black smoke issue out, will presently flame and disappear, or it will evaporate with its flame: the ladle is then hot, put in a second bit, which will produce a white smoke; this white smoke will continue during the operation, and evaporate the caoutchuc; therefore no time is to be lost, but little bits are to be put in, a few at a time, till the whole are melted; it should be continually and gently stirred with an iron or brass spoon. The instant the smoke changes from white to black, take off the ladle, or the whole will break out into a violent flame, and be spoiled or lost. Care must be taken that no water be added, a few drops only of which would, on account of its superior specific gravity (for the caoutchuc swims on water), make it boil over furiously with great noise; at this period of the process, two pounds or one quart of the best drying oil, or even of raw linseed oil, which, together with a few drops of neatsfoot oil, (must have stood a month, or not so long) on a lump of quick lime, to make it more or less drying; being poured off, the lime lees are to be put into the melted caoutchuc, and stirred till hot, and the whole poured into a glazed vessel through a coarse gauze, or fine sieve. When settled and clear, which will be in a few minutes, it is fit for use, either hot or cold. The silk should be stretched horizontally by pins or tenter-hooks on frames, the greater they are in length the better, and the varnish poured on cold in hot weather, and hot in cold weather. It is perhaps best always to lay it on when cold. The art of laying it on properly, consists in making no intestine motion in the varnish, which would create minute bubbles; therefore brushes of every kind are improper, as each bubble breaks in drying, and forms a small hole, through which the air will transpire.

To those who are unacquainted with the principles of chemistry, or the books which teach them, and yet are desirous to make experiments, which may throw light on this curious and useful art, when applied to varnishes for umbrellas or balloons, the following detached notes are recommended, which were communicated by different artists, each eminent in his professon.

To make copal varnish:—procure an ounce of pure fixed alkali,

as potash, reduced to powder, lay it before the fire till it becomes hot and dry; put it while hot and dry into oil of turpentine (a pint, for instance) or into the same quantity of spirits of wine; for, by means of the alkali, all the water invisibly contained in the oil or spirits yield alcohol that is quite pure and highly rectified, which process is called alkalizing the turpentine or spirits. Put the turpentine or spirits so alkalized into a copper vessel with half an ounce of clear dry copal, finely pounded and sifted, stir it, and the copal will soon melt.

N. B. If you alkalize the spirits of turpentine when the copal is dissolving, add a little spirits of wine; and if you alkalize the spirits of wine when the copal is dissolving, add a little spirits of turpentine: the sediment of the varnish will dry on the silk in a few hours; the thicker the varnish, the sooner it dries.

To make an excellent thin varnish:—to one quart of cold drawn linseed oil poured off from the lees (produced on the addition of unslacked lime, on which the oil had stood ten or eight days at the least), in order to communicate a drying quality, or brown umber, burnt and pounded, which will have the like effect, add half an ounce of litharge, boil them for half an hour, then add half an ounce of the copal varnish. While the ingredients are on the fire, in a copper vessel, put in one ounce of Chio turpentine or common resin, and a few drops of neatsfoot oil, and stir the whole with a knife or any clean thing; when cold it is ready for use. The neatsfoot oil prevents the varnish from being sticky or adhesive, and may be put into the linseed oil at the same time with the lime or burnt umber. Resin or Chio turpentine may be added till the varnish has obtained the desired thickness.*

It must likewise be observed, that litharge rots the silk, therefore trials must be made without the litharge.

The longer the raw linseed oil remains on the unslacked lime or umber, the sooner will the oil dry after it is used, if some months so much the better; such varnish will set, that is to say,

* The Editor will be gratified, by knowing from those who may try the above receipts, whether they succeed.

not run, but keep its place on the silk in four hours; the silk may then be turned and varnished on the other side.

On Gum Mastic, Sandarac, Seed-lac, Shell-lac, and Copal.

Gum mastic dissolves without pounding, by adding a few drops of oil of vitriol; so do gum sandarac and gum copal, when finely pounded and sifted.

Gum sandarac and gum mastic are great driers of themselves, and may be substituted for litharge; the mastic dissolved in the oil of vitriol gives a sweet smell to the varnish.

Sandarac will soon grow dusky in the fire; it melts into a transparent green.

Sandarac, seed and shell-lac, must be finely pounded and sifted before used.

Professor Tingry of Geneva, does not seem well acquainted (in the work which was some time ago published on the subject of varnishes, and which is in other respects excellent) with the solution of elastic resin in æther, though he asserts that he has effected it. It is probable that, by the additional pressure of the atmosphere, we shall be able to produce this effect very satisfactorily. Its use in the formation of catheters and bougies is well known. Elastic gum is used by different tribes of the Americans for the purpose of tapers; they make them at least two feet in length, and are said to burn a long time, yielding a considerable portion of light: the elasticity of the elastic gum is increased when the temperature is between 75 and 100°.

AN ACCOUNT OF THE

COAL MINES AND IRON FORGES IN SCOTLAND.

From the Tradesman, or Commercial Magazine,

Aug. and Sept. 1809.

1. *At Carron, near Falkirk.*

THE laws which subsist in the north of England with regard to the working of mines, are the same in Scotland; that is to

say, it is necessary to have the royalty, to be authorized to dig for minerals below ground.

About five or six years ago, the proprietor of the estate and royalty at Carron, wrought the coal on his own account; but what he did was trifling, in comparison with their present state. An English company, composed chiefly of merchants in Birmingham, having examined the quality of the coal, and its vicinity to water-carriage, (it being only three-eighths of a mile from the sea,) and observed that there was also a considerable stream for the use of their machines, took a lease of it from the proprietor for the term of eighty years. They also agreed with the proprietors of the estates between them and the sea; and of those on which they meant to erect their iron works. One proprietor having been desirous to impose unreasonable conditions, they have been obliged to make their road considerably round.

They have discovered three beds of coal under each other, and know not whether there may be any still deeper. The first is about forty fathoms deep; the second ten fathoms lower; the third five fathoms lower still. The inclination, or dip of these beds is one fathom in ten towards the south-east: it has some variations, as we have been shown, which indeed is almost constantly the case with all mines, so that instead of dipping, they sometimes rise to the south-east, and form, between them, two inclined planes. In this case, the bed is impoverished, diminishes greatly in thickness, sometimes is entirely cut off; and so continues till it resumes its ordinary inclination.

Besides this inconvenience, there is the further one, of being obliged to work the sole or pavement of the bed, in order to drain off the waters to the deepest pit; for which there is no necessity when the bed preserves its dip and direction.

In the old mine they are working only the upper seam, but in the new mine they work the second, which is best adapted to the use which we shall mention below. This is from three to four feet thick; consisting, in its upper part, of a hard compact clear burning coal, called *splint coal.* These are not consumed in the country, but sent to London, where they are preferred to the

Newcastle coal for burning in apartments. The middle of the seam is of a softer quality; it contains leaves, and separates into plates, like the schistus. Between the plates there is a very singular appearance, perfectly resembling charcoal dust, and staining the fingers, as it does. This, which is called *clod-coal*, has very little of a soldering, or caking quality. It is used only for the iron forges. The third part, or lower bed of the seam, is a very compact, and (often near the sole) even stony coal. This is used for the fire-engine; and vended for the consumption of the country.

This seam, as well as all the rest, is wrought by undertakers, the workmen being paid according to the work done. They are associated together in companies, and furnish their own tools and candles. They are paid three halfpence a cwt. for the good coal, that is to say, for the two higher beds; and only one penny for the inferior, or lower, which is sold in the country. There are some workmen who gain as much as twenty shillings a week, and work no more than seven or eight hours a day.

Every company of workmen is divided into two bands, one to work in the morning, the other in the afternoon. The work of the *morning-band*, is to cut out the lower bed; for which they have picks pointed on both sides. The after-dinner-band has only to bring down the two wedges, which they place between the coal and the roof; and by striking which with iron mallets, they bring down the good coal in very large pieces; which is necessary, both for the London markets, and the iron forges.

They leave no pillars in the mine; but work at first only on one side, supporting the roof with straight pieces of timber, six or eight inches thick; which they draw in proportion as they advance, leaving behind them the rubbish, upon which the roof sinks without any inconvenience; it being always supported by props in the places where they are at work.

The rocks which compose the roof and the sole are like those at Newcastle, already described.

They lead the coal from the principal pits by the four-wheeled wagons upon wagon-ways, as at Newcastle. Into the old mine,

where the works are more extensive than in the new, they have taken horses, which never come out again. These horses draw the coals where roads are constructed for that purpose; where they are not broad enough, the coals are drawn by men. And where there are as yet no roads made at all, they have little trams, drawn by boys.

In general, the engine and gin-pits are round, and about twelve feet wide. They are lined with brick or stone walls, from the surface to the solid rock; which supports itself without walling or frame work.

They do not make use of corves, as in the north of England, but draw the coal in square chests of about two feet and a half in each dimension; they are made of boards well bound with iron. The bottom forms a door, which opens by means of a hinge.

These chests are raised by gins moved by two horses. There is at the pit-mouth a moveable gibbet, with a rope, which is coiled round a windlass. This rope passing over a pulley at the extremity of the gibbet, suspends an iron crook directly into the pit, so that when the coal-chest is at the top, they hook it upon the cord, and disengage the hook of the gin-rope, to which they hang another empty chest. The full one being thus suspended on the gibbet, it is turned on one side; the bottom of the chest is opened, and the coal falls into the place appointed for it. The bottom is then closed, and the gibbet turned to bring back the chest to the pit-mouth, where it awaits the arrival of that which is coming up. This machine appears very useful, since it saves a horse, which as has been shown, is employed for this purpose in the north of England.

Each of these mines has a fire-engine, with a cylinder of fifty inches diameter. There is only one boiler at the new mine; but they are on the point of adding a second, that they may have it in their power to repair one while the other is at work. They are constructed entirely of iron-plates; which are painted on the outside with white-lead and oil, to prevent the rust, as they are placed in the open air, without any cover. In the inside they

put between the joints of the plates, a cement composed of quick-lime and ox-blood, to prevent the escape of the water.

They make use in these mines of high pumps, the diameter of which is commonly thirteen inches.

There are five species of the mineral, or rather five places whence it is obtained; for in quality they are much alike. They are none of them rich, yielding not more than 30 *per cent.* of pig iron. It is called *iron stone.* In the smelting there is added to these five sorts, a sixth very rich one, which is brought from Cumberland, and is called *iron ore.* It is much the same as the Germans called *glass-kopf.*

The iron stone nearest Carron is at three miles distance from the works; to which it is led across a very wide heath. It is found in a valley, separated by a brook, the royalty on each side of which, belongs to different individuals. They pay to each a shilling for every ton (21 cwt.) of iron stone extracted.

The iron stone is found in a sort of clay bed, which lies nearly horizontal, with a small inclination to the south-east. The brook which crosses it has entirely divided it, and so formed the valley. The clay contains the iron stone in lumps, of all sorts of forms; but the most common is flat, and rounded at their extremities. This configuration may give room for various questions. Is the mineral gradually forming, or in a state of gradual destruction? Or has it been in part destroyed by currents of water?

Below this bed of clay, is a stratum, many inches thick, of a blackish-blue *schistus;* similar to that which is found over every seam of coal in the country. In fact, it serves here as a roof to a seam, about six inches thick, of pretty good coal. Sometimes the coal is in immediate contact with the iron stone. Above the bed of clay, are many irregular beds of a whitish *schistus;* and over these a sand stone, which serves as a support to the works which are driven for obtaining the iron stone, with the help of small pieces of straight timber, which are put in at proper intervals.

The iron stone is extracted by a number of undertakers, (master workmen, or piece masters) who have each their journeymen.

They are paid by the cubic measure of ore wrought, so as that their wages amount to about ten shillings the ton of picked ore. They work along the valley, enter under ground as little as possible, and leave pillars of the clay where it contains no iron stone. They work more easily on one side of the valley than on the other, because they can begin by extracting the coal, which undermines the iron stone. They cannot do this on the other side, the proprietor of the royalty having forbidden them to touch the coal.

The iron stone is of a black gray colour, close grained, and resembles none of the ores of iron which I ever saw before. There are some pieces which, on breaking, have irregularly formed cavities within, lined with a whitish very tender substance; and this is said to be of the best quality.

This stone reddens a little on roasting, and puts on the appearance of an ordinary iron stone. This species is very common, not only in Scotland, but also in the north of England; and is always contained in the same beds, and lying above a bed of coal.

Operations of the Furnaces.

The *iron stone* is roasted before it is taken to the smelting furnace. For this purpose, they spread upon the ground a bed of large coals, eighteen or twenty feet long, and six or seven broad; on which they place the iron stone, in pieces of seven, eight, or nine pounds weight. They give it the form of an ass's back, making it about three feet high in the middle.

This done, they set fire to one of the ends; and, in proportion as the fire advances, they cover the whole with coal dust and ashes, in order to concentrate the heat. It takes many days for the fire to penetrate the whole mass, which is roasted sufficiently by this operation.

The *iron ore* requires no roasting; but is smelted raw with the other minerals, as will be described below.

To render the coal proper for smelting, it is reduced into coaks; which is done as follows. The species of coal most suitable for this operation is called clod coal, which is the middle

part of the seam. A round bed of twelve or fifteen feet diameter is formed upon the ground, and surrounded with a mixture of coal dust, and ashes, the remains of former operations. This circular bed is not more than seven or eight inches thick at the edges, and a foot and a half in the middle or centre; at which place they kindle it with lighted coals, and the fire quickly spreads throughout the whole. The man who takes care of the operation, with an iron peel takes up the dust which lies round, and throws upon the places where the fire is too hot, such a quantity of it as may serve to prevent the consumption of the coal, but not enough to extinguish the flame, which spreads over its whole surface, and is a mark of the destruction of the bitumen, the real object of the operation. The dust serves also to extinguish it when it is deprived of its bitumen; which, in this coal, is not very abundant. This operation takes about forty hours.

The coaks being thus prepared are employed alone, and without any addition of coal, to smelt the iron stone in two large high furnaces placed by the side of each other. They are like those which are used in Germany, and in many provinces of France. I was informed that they were thirty feet high, the inside forming an oval, the larger diameter of which is eight feet. Each furnace has two very large single leather bellows, moved by a large wheel, on the axle of which are four *cammes* for each bellows.

In these furnaces they smelt the six different kinds of minerals which we have described above, viz. The five kinds of iron stone which have been previously roasted, and the iron kidney ore, a little of which is added at each charge, in its raw state. A little limestone is mixed, to serve as an absorbent; and the whole is covered with coaks.

The flame which rises from this furnace cannot be distinguished from that which is produced by the charcoal furnace: the operation also is in every respect the same. They run out the metal every twelve hours, about forty cwt. each time.

It is surprising that the metal proceeding from this furnace, which, as will be shown, can never produce a good forged iron,

should be so soft as it is. It may be filed and cut almost as easily as forged iron; which is a great advantage in the forming of all sorts of cast metal goods. And this is the principal object of this establishment. They cast here, particularly, the largest cylinders for steam engines; in the same manner as a very considerable iron forge established in the principality of Wales.*

We saw a cylinder of this kind, of fifty inches diameter. For this purpose they have a very large pit before one of the furnaces, in which channels they place the moulds of the different pieces they mean to cast; and by furnaces, and even from different reverberatory ones, when they have to cast a piece which requires more metal than the two high furnaces can furnish. There are five of these reverberatory furnaces disposed in such a manner that they can make the metal run from them into the same pit. By this means they could cast a piece of twenty tons weight.

These reverberatory furnaces are constructed and wrought in the same manner as I have described above. They are kept in daily use, and are commonly tapped twice a day. They are left to cool during the night, and are repaired in the morning, by making them a fresh bottom of sand. In these are melted the refuse of the high furnaces, that is to say, the small pieces, broken work, and old cast metal, which is brought from different countries, as well as pig iron.

The principal object is to cast all sorts of small works, as iron grates for fire places; different ornaments for the same; ship stoves and grates, iron grates, smoothing irons, kettles, &c. &c. Since the conquest of Canada, these forges have entirely supplied that colony; and they have followed the same patterns as were formerly used in France. Lastly, they make of cast iron many of the same works as are commonly made of wrought iron: and polish them by water mills similar to those which are used near St. Etienne en Forez.

The metal cast into works is sold at from ten to thirty shillings per cwt. The last price is commonly given for large cylin-

* The Wilkinson's, near Wrexham.

ders, after they have been bored and polished within. The earth employed for the composition of moulds for the cylinders is a clay well kneaded and wrought, and mixed with hair well beat in. The mould for these cylinders consists of a smaller cylinder of iron, round which they place bricks, and over them earth, till it is of the required diameter: and as these pieces are too heavy to be turned, the mould is placed vertically: a pivot which is moveable in the middle of it, and to which is fixed a square, by turning gives the true proportion.

They bore, or rather take away the inequalities, and polish the inside of the cylinder, by the help of a great water wheel: one of the trunnions of which is very long. At the end of this they fix a wheel of cast iron, of a diameter proportioned to that of the cylinder to be bored. The circumference of this wheel is divided into six parts, by as many grooves or notches, into each of which is put a piece of steel moderately sharp, so as that the whole may equally exceed by not more than an inch, the diameter of the wheel. These pieces of steel are very firmly fixed with iron wedges. They are taken out from time to time, to sharpen them on a grindstone: because it is necessary that they should all take hold (fr. bite) as nearly as possible at the same time. The wheel or borer is made to enter the cylinder, which is placed horizontally upon a frame of wood, which is brought forward or backward as it is required, by means of a windlass. The great wheel is then put in motion: two workmen conduct the operation, which is performed with precision and quickness.

One thing very surprizing in this manufacture, and which is seen no where else, is a high furnace which has been at work, as we were told, four years without interruption; and it is expected to go another year still. The second has been at work three years. In all other places, the operation of smelting in the high furnaces of iron forges is not continued for more than a year at farthest.

The directors do not find the blast of their bellows strong enough. They are constructing two new ones of a prodigious size: these will also be single, but two and twenty feet long,

made of oak planks at least two inches thick. These bellows will cost more than £. 300 sterling. If they were acquainted with the use of double wooden bellows, it would save them much expense.*

Besides the cast iron works, which form a very considerable establishment, they have one, in the same place, of wrought iron, which is not less so: but as the metal proceeding from the pit coal furnace is of a quality unfit for being reduced into forged iron, they import a great quantity of American and Russian pigs, which are pretty nearly of the same quality. They serve to meliorate their own, by the mixture which they make of them in their refineries; the operation of which is performed only with charcoal, and in the same manner as every where else. They assured us that they did not refine also with pit coal; but we found it difficult to believe them. All that we observed was, that, after the refined iron was come out of the refinery, and had been once under the hammer, it was heated a second time upon a hearth in the same building, the fire of which was entirely of pit coal.

The proportion of the mixture of the different kinds of pig iron depends entirely upon the quality of wrought iron they want. For large articles, for instance, they employ a greater proportion of Carron metal, than for small ones, or for strong iron plates, a great quantity of which they manufacture for boilers in steam engines.

The way in which they heat the plates in order to extend them under the hammer, deserves attention.

The furnace is a common smith's hearth with a double bellows, before which, however, is formed an arch of coal, which is moistened for that purpose. There is besides a plate of cast iron before, to support the arch. The fire is kept up with small coal, which is put in from time to time. They then put in the plates, which are heated in a very short time by the action of the flame.

* When were the iron cylindrical bellows first introduced, where, and by whom?

They are found to be in this way cleaner and less damaged than when they are suffered immediately to touch the coal.

They have another way of partially heating the pieces, especially if they be large, when they wish to lose no time. There is near every forge a small reverberatory furnace, where they previously heat the iron, before they put it upon the hearth before the bellows. In this way the operation goes on more quickly, and the hammers are always in motion. These hammers are of different sizes, moved by water in the common way, and have nothing remarkable in them. In most forges a dome and chimney is built immediately above the *tuyere* of the bellows, to receive the smoke; by which means the workmen are very little incommoded. These are even constructed over small hearths, where the bellows are moved by the hand.

In these works they manufacture all kinds of small iron goods, such as frying-pans, nails, &c. but for these they employ Swedish iron. That which is made there is not soft enough for this purpose.

The farmers of the mines, and the directors of the forges employ in all about 800 men; who all work at settled wages, of so much a cwt. of wrought iron. The best workmen may get about twenty shillings a week.

These works are undoubtedly some of the most complete of the kind. Every thing contributes to make this establishment advantageous. The directors work their own coal, and that near the works. They have a very good stream of water, for which, indeed, they are at considerable expense. They are, besides, very near a sea port. The company is very numerous; the partners residing in London, Newcastle, and Birmingham: those of the last mentioned place are the richest and most industrious. One of them has taken a farm within seven miles, and goes to Carron every week. Lastly, one of the partners resides upon the spot, directs all the operations, which he understands very well; whilst the rest exert themselves in their several places of residence, to augment the consumption of their manufactures.

ON IRON.

IRON is the most abundant and most useful of all the metals; the strong cohesion of its parts is frequently attended with toughness and ductility, or hardness, or elasticity. It can be softened by heat, compressed by rollers, cast in moulds, and welded. The property it has in steel of striking fire with flint is peculiar; and its obedience to the magnetic influence furnishes to the mariner means of piloting ships through the trackless ocean.

A wire of one-tenth of an inch can sustain 450 lbs. whilst one of copper only supports 300 lbs. A mass of iron of 1600 lbs. weight has been found in Siberia, and a large mass in South America, in a native state, where this metal too is by no means so abundant as it is in Europe. Steel on collision with flint or iron exposed to vital air, or at the point of incandessence in the atmosphere, has the property of brandishing or coruscating in a very beautiful manner, or when its powder is thrown through the flame of a candle. On exposure to heat and air, a faint yellow, golden, purple, violet or deep blue, terminating in a water colour, are induced by iron. When long calcined, red oxide or the martial *croci* are produced.

All matters, especially such as harden in the air, and polish by means of cutting powders, which are rubbed on with grease, or throwing the iron into lime water, preserve it from corrosion. When iron is dissolved in sulphuric acid and water, a sort of plumbago is precipitated scarcely alterable by fire, and requiring much nitre for its detonation. Vitriol may be calcined to whiteness, to a light red, to redness, and to calcothar. In its highly oxidated state, it has a deep red colour. The nitric acid with iron filings, produces violent effervescence; nitrous gas being formed whilst the iron is oxidated and partly dissolved.

One ounce of fine iron filings, six ounces of muriatic acid, and two and one-half of water, after mutual and complete action, yield crystals of a bright green colour, at common temperatures.

If muriate of iron be exposed to heat in a retort, and that heat

be gradually increased, there will remain at the bottom a mass of scale-like crystals, and in the neck of the retort. This deliquescent substance, when digested with three times its weight of sulphuric ether attaches the colour to itself. If to this seven parts of alcohol be added, it forms Bestichef's drops, or *teinture d'or*, which become colourless when for a few minutes exposed to the sun's light, but have in the dark a beautiful golden hue.

From the affinity of the oxide of iron, when combined with acids for more oxygen, we understand the origin of the great quantity of ochre which mineral springs deposit in their course, and the permanent yellow stain left upon white cloths and linens by that metal. The muriatic acid is the most powerful solvent of the calces of iron; it must be applied to cloths in a state of high dilution.

Alcalies when added to a solution of iron in acids, as potash to the fresh made green vitriol, forms a precipitate of a bluish green. In some cases, the precipitate can be redissolved, as in forming the blood-red solution, or alkaline tincture of Stahl, from nitrate of iron.

Iron is precipitated in forming ink, and the black dye, by vegetable astringents. The difference between an old and new solution of iron is considerable in this respect; for a deep black, the former is far preferable. If a little infusion of green tea be spilt on a knife, it becomes tinged with an inky blackness, or a piece of moist iron when laid on an oaken table stains it black; tanned leather becomes black when moistened with vitriol. There is a leather made by a secret process at Liverpool, and whence ordinary bark is not used, but some weed or root, and which does not change colour with copperas.

Iron with the Prussic acid forms a bright blue substance. This blue is much heightened by a little ruddy nitric acid, or acid containing nitrous gas in solution.

A dram of flowers of sulphur, two drams of iron filings, and as much water as will make it into a thick paste, when put into a jar holding nearly two quarts of atmospheric air, absorbs the whole of the oxygen. Where this is effected upon a large scale,

much heat is employed, and this happens even in receivers considerably exhausted, in consequence of the oxygen still entangled in the mixture.

Iron when combined with phosphorus in small quantities, is necessarily decomposed, it gives to iron the property of being "*cold short*," that is, it cracks on being hammered out when cold. With the exception of lead and mercury, iron combines with all the metals.

With arsenic iron becomes "*red short*," that is, apt to crack under the hammer and fall to pieces.

Iron is found in many of the productions of nature, as in coloured clays, the bolar earths, the garnet emerald, ruby, topaz, sapphire, and amethyst; these owe their colours to iron.

Some ores of iron are used by the artist, as emery by the lapidary, hæmatites for the burnisher; red, yellow, and blue ochre, for the burnisher. Load-stone furnishes the means of making his compass to the mariner.

In reducing iron from its ores, much fuel should be used: in Scotland, says Dr. Black, from three to four times its weight of soft pit coal is employed. To obtain a ton of iron, 672,000 feet of common air is employed, and a greater proportion in winter.

Pig iron or pot metal, is the state in which iron first appears on extraction from its ore. Though perfectly fusible, it is brittle, and scarcely at all flexible. From its fusibility, however, instruments of a large size can be formed at a far less expense than they could be forged for; nay, where large ones could not be forged at all.

But where it is necessary that the iron should be exceedingly strong and tough, as in anchors and the like, fusible iron is unfit. I should observe, in this place, that the cast iron obtained by this process appears in three states, which are very distinguishable, both in appearance and qualities, according to the manner in which it has been manufactured.

Whilst cast iron is extremely hard and brittle, it cannot be filed, or bored, or repaired in any way, nor will it bend. It cannot bear very sudden changes of temperature without crack-

ing. Its structure is crystallized with various very small but brilliant facets.

Gray cast iron is of a granulated texture, and often in plates or lamina, but of an unequal dull colour. It is much more cohesive that the former; and is therefore employed for artillery, it is also softer, and may be cut and bored, and even turned in a lathe.

Black cast iron is the most unequal in its texture, the most fusible, and therefore it is often mixed with the white to make it stand in certain heats. It is less tenacious than either of the former.

By an operation in the finery or forge, iron is changed from its fusible and rigid state, into tough and malleable iron. The iron has for this purpose a strong flame blowing over it; and to keep it in a most intense heat, every part is brought to the surface in succession by a rake. It swells, a dazzling brightness appearing on its surface, and a gleam of flame, it is said to be *brought into nature;* when it has thus lost its fusibility and becomes malleable, it is collected into masses in the laboratory of the furnace, by raking it together, and compacting it with the strokes of an iron club or mace. These masses are very porous and spongy, and contain a great deal of scoria, or semi-vetrified matter mixed with the iron. The heat to which they are exposed is then increased for a short time until the scoria are completely separated, at which time the *loop* is taken out,* and immediately exposed to the strokes of a large and heavy hammer, wrought by a water wheel or steam engine. This compresses the mass, unites the parts of it more closely, and forces out the greater part of the vitrified matter, or finery cinder, as it is called, out of its pores. The mass is turned under the hammer until it is formed into a short and thick cylindric form called a bloom,† the parts of which are not yet so closely united as they ought, but by heating it again, and subjecting it to the great hammer, or passing it between rollers contrived for this purpose, the parts of

* The Scoria are first let off.—*Editor.*

† Commonly called a "half bloom."—*Editor.*

it are made to enter into close cohesion, the liquid dross completely squeezed out of its pores, while it is at the same time forged into bars of different kinds.

The iron made by this process, from very ordinary iron, such as was known to yield bad bar iron, proved equal to the best Swedish iron. Very severe trials were made by government, as it was recommended for the use of the navy, for anchors, bolts, straps of blocks, and other uses where toughness was an indispensable requisite. But to make bad iron so eminently good, requires much labour and expense. Cast iron, which yielded better bar iron by the usual processes, is reducible to the same degree of fineness with much less trouble. I mention this circumstance to show that the process is general, and depends on principle.

By this process, the expense of wood charcoal, which is very dear fuel in this country, is saved. The whole operation being performed by the flame and heat of pit coal.

By whatever process fusible iron is refined to the state of tough iron, a considerable part of it (one third commonly) is scorified or calcined, forming a fusible calx or oxide called finery cinder. It is exactly similar in its appearance to the fusible oxide from iron, when it is formed in vital air. The productions of this finery cinder is absolutely necessary, and skilful workmen say, that for the right performance of this process, it is necessary that the refining iron be well soaked, and mixed to a certain degree with this finery cinder, for which reason, although they let some of this cinder run out at a tap hole of the furnace or forge, when it accumulates too much, they never let it all run out, but retain a proper quantity in the furnace or forge all the time they are working.

But it is also certain that the iron loses a quantity of inflammable matter, which is contained in it while it is in its brittle and fusible state. While the workmen are busily employed in stirring it over from one side of its bed to the other, separating it into small parts, and mixing the whole carefully together, a quantity of iron to which the air is admitted all the while must be calcin-

ed or oxidated, he then increases the heat a little, to make the oxygen of this calcined iron act on the carbon of the uncalcined. This increases the heat in the iron and produces the carbonic acid gas, which, while it rises, carries some carbon with it, and hence the blue flame. The nicety of this operation depends on knowing how far to carry the calcination of part of the iron; there may be enough of the oxygen to consume the whole of the carbon. If more iron than enough be calcined, it is so much lost.

The very best kinds of refined or bar iron are very strong and tough when cold, and bear to be bent backwards and forwards very much before they break; and they are also very malleable when hot. Sweden is remarkable for producing iron from some of its ores, and this of the very best quality. But the greater number of iron ores do not produce iron so good, though it be good enough for common uses.

The blacksmiths distinguish the common kinds of iron into two varieties, of which, however, there are many degrees. To those two varieties they give the names of red short iron and cold short iron.

The red short is tough and flexible when cold, and works very well when strongly heated, but if under heated it is brittle under the hammer; and as there are many varieties, the smiths make trials at first, to learn how the iron is best wrought. The cold short iron if cooled slowly after being heated, proves quite brittle when cold, especially thick bars of it, and acquires flexibility by being plunged redhot into cold water, but is always deficient in it. In its brittle state it breaks so as to show facets or plates remarkably large in the surface of the fracture.

Professor Bergman made a great number of experiments to learn the causes of the different qualities of iron, and thought he had discovered the cause of cold shortness, ascribing it to the presence of a metal which he called siderum. But this has been found to be a mistake: Meyer showed that it was phosphate of iron. Mr. Cort's process removes or prevents this bad quality. When a piece of tough hammered iron is broken by bending, it is found to be fibrous; but if the same piece be kept redhot for

some time, and again broken, the fibrous appearance is almost lost. It would seem, that it gets it by the action of the hammer, and that iron consists of malleable infusible stuff, mixed with a remainder of fusible iron. Such a mass, when heated redhot, must work under the hammer like a paste in kneading, the fluid part being squeezed along between the ductile parts like so much grease. Perhaps this is the source of that shining or glowing skin which it gets in a welding heat, which enables two pieces to be struck together by the force of blows. I have now described the progress of iron from the ore to that state of this metal which appears to be the most pure and perfect state of it, and in which it is called tough iron or bar iron. I must, in the next place, give some account of steel, which is iron in a different state, and possessed of properties by which it is much better adapted to serve some of our purposes than tough iron is.

Steel is refined iron, intimately combined with a small quantity of pure carbonaceous matter, or the carbon of the French chymists.

Slender bars of iron are put into a crucible, and covered with charcoal dust rammed close round them. The crucible is luted, and set in a furnace, where it is exposed to a strong red heat for some hours. When the iron is taken out, its surface is frequently found rough and blistered: this I believe is owing to pushing the operation a little too far. It is now converted into steel, and considerably increased in weight.

This process is a cementation, and the carbonaceous matter must be introduced into the iron in the form of heavy inflammable air. In the experiment of Mr. Morveau, in which he exposed a diamond to intense heat, shut up in a small cavity in tough iron: the diamond vanished, and the iron around it was converted into steel. These facts show very plainly what happens. The charcoal or carbon in substance combines with the metal.

A fine steel wire burns with amazing brilliancy in vital air, and produces both fixed and inflammable air. This carbonaceous matter is discoverable in steel by the action of acids, particularly the nitrous acid.

The cast iron resembles the steel in this, that, like it, it contains much inflammable matter, which it got from the fuel, and which remains defended from the action of the air by the very fluidity which it occasions, and which is expelled only by stirring and presenting a great surface for a long time to the action of the air.

This notion is confirmed* by the fact, that a slender rod of iron plunged into white or gray cast iron infusion, is converted into steel.

The qualities of steel, by which it differs from iron, are, it is more fusible. Tough iron cannot be melted in the most violent fires of common furnaces. It only becomes very soft, but never fluid. But steel can be melted perfectly in crucibles, if exposed to the most violent heats of common furnaces.

Steel is much more readily broken by bending it than iron which is tough. It does not appear to be so much bent backwards and forwards; when a bar of it is broken, the fracture of it is quite different from the fracture of iron. A bar of tough iron exhibits a fibrous appearance on fracture, the surface of which being very rough and rigid at the ends of the respective fibres, although when broken it shows that it is composed of strong grains of a plated structure, and presents a whitish-gray surface much plainer than that of broken iron.

The most useful qualities by which steel excels iron, are the strong cohesion of its parts, and the extraordinary hardness it acquires on being suddenly cooled after having been made redhot. It can thus be hardened to so high a degree, as not only to cut iron with ease, but even steel itself, in its softer state. Dr. Black asserts, that a steel wire of one-tenth of an inch in diameter, will just break when loaded with 900 lbs. weight, if properly tempered; but it will lift upwards of 700 lbs. weight in its tough state.

This excessive hardness is attended with perfect rigidity and inflexibility; and, in consequence of such hard state, steel is to a

* Should not finery cinder, and all pure oxides of iron, when reduced by charcoal and proper fluxes, in the nice experiments of the laboratory, be steel and not be iron? Are they always so? We think not.

certain degree brittle. Files, for instance, when hardened to this degree, can be broken, if simply dropped to the ground. It is hence very obvious that no fact can be of greater importance to the artist, than to know how to give to steel an exact degree of temper, varying however correctly according to the various purposes to which that steel is intended to be applied. The wotz of the Indians has very remarkable qualities, and may be considered as steel of a very superior kind, or at least of having properties equal to steel of the first manufacture. When the surface of any piece of steel, after having been cleaned perfectly by polishing or grinding, is heated again to a certain temperature, it first acquires a straw colour, which will gradually, on receiving a higher heat, change to a full gold colour with ruddy purple streaks, then afterwards become of a full purple violet, and lastly ultra marine blue. These colours respectively direct the artist to stop within that range of temperature at which they occur, to arrest the temper, which is done by plunging the metal into cold water or grease, which by particular artists is occasionally employed. We do not ever recollect that quicksilver, which is a rapid conductor and abstracter of heat, as is known by the speed with which it robs the animal body of its warmth, has ever been employed by the artist on a large scale, to attemper iron or steel. But as it does not amalgamate with iron, we have no hesitation in stating, that, for the nice purposes of particular arts, the hint we give is worthy the consideration of the artist. A little nicety of the eye fits him for ascertaining the degrees to which we refer, though no simple experience of cultivated vision can be physically exact, and the pyrometer and thermometer are less easy of application in these instances than any others.

The first degree of yellow, in the act of tempering, fits the steel for the requisite hardness wanted in the edges of chisels and punches which are to be employed upon iron itself. The full gold colour, or incipient purple hue, fits the steel for chisels which are to be employed upon the softer metals; if we go on to a somewhat deeper tint of purple, we obtain that state which is best adapted for edge tools; while the full violet or blue is the condition al-

ways sought in the manufacture of watch springs. When clouds of a dingy yellow, which will occur, unless care be used, intersect the blue, a degree of softness foreign to the views of the artist is produced.

We know not, with respect to steel, a greater desideratum than to combine this extreme hardness, of which it is capable, with the toughness and tenacity of iron; and the only way which, at present, this is accomplished, is by welding steel and iron together, as we are all acquainted with the common operation of the blacksmith, who adapts his tools, such as chisels, &c. to the purpose of the mason, in the making of horse-shoes, and for cutlery and other uses. A plate of steel is welded to a suitable portion of iron, on that side of the plate or bar which is to be worked to an edge. It may not be amiss to add, that welding, or the operation of uniting metals without solder, alone applies to iron and platina.

There is another way found to be, on peculiar occasions, of particular service; we mean the conversion of the surface simply of any given piece of iron into steel. This is done by a process termed cementation, which process can be stopped before the surface has been so far penetrated as to convert the whole substance of the iron into steel. This operation is termed case-hardening: the work, when nearly finished, is covered with a paste, consisting chiefly of charcoal or carbonaceous matters. Long experience has yielded a universal preference to the charcoal of animal substances, or we would rather say to the crude substance itself. Hence the use of horns, hoofs, chopt hair, bone shavings.

TO CLEAR FEATHERS FROM THEIR ANIMAL OIL.

BY MRS. JANE RICHARDSON, OF CHELSEA.

From the Transactions of the Society of Arts, London, volume 23.

FEATHERS must be freed from their oil before they are fit to put into beds, otherwise they become infested with insects, or smell offensively. The common process is to bake them; but in

thus treating them, they are often singed: the following method does not seem liable to any objection, and promises to be a useful addition to our stock of economical knowledge. Several certificates from dealers in feathers in London, testified to the efficacy of Mrs. Richardson's process: and the society, with their usual generosity, accordingly presented her with twenty guineas in January 1809.

"Take for every gallon of clean water, one pound of quicklime; mix them well together, and when the undissolved lime is precipitated in fine powder, pour off the clear lime water for use at the time it is wanted.

Put the feathers to be cleaned in another tub, and add to them a quantity of the clear lime water, sufficient to cover the feathers about three inches, when well immersed and stirred about therein. The feathers, when thoroughly moistened, will sink down, and should remain in the lime water three or four days, after which the foul liquor should be separated from the feathers by laying them on a seive.

The feathers should be afterwards well washed in clean water, and dried upon nets: the meshes about the fineness of cabbage nets.

The feathers must from time to time be shaken upon the nets, and as they dry, will fall through the meshes, and are to be collected for use. The admission of air will be serviceable in the drying: the whole process will be completed in about three weeks. After being prepared as abovementioned, they will only require beating for use."

COMPOSITION TO PRESERVE WOOD.

From the National Intelligencer.

MR. GALES,

IT becomes important to have a simple composition, in the application of which, the durability of bridges constructed of wood

will be extended for a long period of time without a roof; whereas, if left exposed to the weather, ten years is their estimated limit of duration. It well deserves the attention of the directors of the city bridge company, for, as the timbers are new, well seasoned, and have suffered no apparent decay, the mixture being now put on will be in time to prevent the operation of the root.

I send you two receipts, one for the preservation of wood or timbers liable to be injured by the weather; and one for the roof of a house, to defend it not only from the weather, but also from fire, and I doubt not, they will both be acceptable to many of your subscribers, among whom I am **ONE.**

CITY OF WASHINGTON,
17*th June*, 1811.

Composition for preserving weather-boarding, and all other work liable to be injured by the weather.

Lime, it is well known, however well burnt, will soon become slacked by exposure in the open air, or even when confined in a situation, if not remarkably dry, so as to crumble of itself into powder. This is what is called air-slacked lime, in contradistinction to that which is slacked in the usual way, by being mixed with water. For the purpose of making the present useful composition to preserve all sorts of wood works exposed to the vicissitudes of the weather, take three parts of this air-slacked lime, two of wood ashes, and one of fine sand, pass them through a fine seive, and add as much linseed oil to the composition as will bring it into a proper consistence of working with a painter's brush. As particular care must be taken to mix it perfectly, it should be ground on a stone slab with a proper muller, in the same manner as painters grind their white lead, &c. But where these conveniences are not at hand, the ingredients may be mixed in a large pan and well beat up with a wooden spatula. Two coats of this composition being necessary, the first may be rather thin, but the second should be as thick as it can conveniently be worked.

This most excellent composition for preserving wood when exposed to the injuries of the weather, is highly preferable to the customary mode of laying on tar and ochre. It is indeed every way better calculated for the purpose: being totally impenetrable by water; and so far from being liable to injury by the action of the weather, or heat of the sun, that the latter, though such a powerful enemy to tarred and ochred pailings, &c. even hardens; and consequently increases the durability of the present proposed composition.

Another receipt for the roof of a house, to defend it from the weather and from fire.

Take one measure of fine sand, two measures of wood ashes well sifted, three of slacked lime ground up with oil; laid on with a painter's brush; first coat thin, and second thick.

I painted on a board with this mixture, and it adheres so strongly to the board, that it resists an iron tool, and put thick on a shingle resists the operation of fire. I used only a part of the mixture; what remains continues in an iron pot; water has lain on the mixture for some time without penetrating the substance, which is as hard as a stone.

ON THE USE OF IRON PIPES FOR CONVEYING WATER, AND MODE OF SECURING THEIR JOINTS.

In a letter from Mr. Joseph T. Price.

From Nicholson's Philosophical Journal, for June, 1811.

TO W. NICHOLSON, Esq.

Esteemed Friend,

IF the enclosed facts should appear to thee likely to be of any service to those, who may want a supply of water conveyed from

any distant source, thou art welcome to give them to the public in thy Journal.

I am,

Thine very sincerely,

Neath Abbey, J. T. PRICE.
14 *Feb.* 1811.

Mr. H. B. Way, of Bridport, had occasion, in 1805, to lay down between eight and nine hundred feet of iron pipe, in lengths about 6 feet each, and 3 inches in the bore. At every 50 feet was a joint with flanches and screws; the other pieces were put together spigot and faucet fashion. To make these tight, he wrapped round the spigot end some canvas well saturated with white lead mixed with oil, to a proper consistence, and drove it into the faucet end as tight as possible. When a length of 120 feet was laid down, the end was plugged up to try the joints; and it was found, that two thirds of them leaked considerably. Being informed by a neighbouring mason, that a linen manufacturer had completely stopped the leaks in his bleaching cisterns, in which lye both cold and boiling was used, by means of Parker & Wyatt's Roman cement, he procured some of this, and luted every joint with it. In 12 or 14 hours the pipe was tried, and found to be perfectly water-tight at the joints; but one of the pipes had a crack in it, which leaked, and this was as effectually stopped by the cement.

The lead pipe, used in the house, had also a leak in it, which was stopped in a very short space of time by the cement.

This work was done between the 10th and 24th of December, in very frosty weather; and the pipe was covered with earth before the end of that month. It is about two or three feet beneath the surface, in a loose, sandy soil; and was kept constantly full of water, without any appearance of leaking.

The water was so much discoloured by the iron for a week or two, and on standing deposited so much sediment, that it could not be used. To remedy this, the same mason recommended to put some unslacked lime into the upper reservoir, or head of

water, and open all the cocks below to give it a quick run; which he said would leave a coat of lime round the inside of th epipe, so as to prevent the rust from coming off. This was done, and for a few days after, the water tasted very much of the lime; but the taste soon went off, and the water, which is very soft, was as good after it had passed through the pipe as at its source.

In the following autumn the same gentleman superintended the laying down of 360 feet of similar iron pipe, with a fall between 20 and 30 feet, the joints of which were secured in the same way. The supply of water here was so copious, that it was obliged to be kept running all night and great part of the day. This soon cleared the pipe from rust, so that after a few days the water came through colourless, and consequently no lime was used.

In the summer of 1808, or 1809, two more pipes were laid down in the neighbourhood in a similar manner, extending together between two and three thousand feet; and with equal success.

These were all perfectly sound and secure, in the month of February last; a little before which, Mr. Way having occasion to put a new leaden pipe in his yard from the iron one, found the latter, as far as it was examined, apparently as good as when laid down, and the cement as perfect, only seeming harder.

REMARKS.

Parker's cement, mentioned in the foregoing paper, is a patent English invention, which sets and hardens to a very considerable degree, in water, in the course of twenty minutes, and that in an equal degree through the whole body of the mortar: even when kept constantly under water, it acquires in a few days a degree of hardness nearly equal to that of the hardest stone. It is not for sale in the United States; but it would be unfortunate if we had not in our power other cements, that would answer as well. The following is recommended to stop holes in iron culinary utensils by Kastelyn; and may probably answer the purpose of

uniting the joints of iron pipes:—Take six parts of potter's yellow clay, add one part of steel filings, and a sufficient quantity of linseed oil to make the paste of the consistence of glazier's putty, and fill the holes therewith.

Borings or turnings of cast iron, mixed with sand and sifted, when added to a paste composed of two parts of sulphur, and one of sal-ammoniac, and a little water, mixed with a portion of urine, and spread upon or between flanches of iron pipes, or put into the interstices of other parts of iron works, will in a little time become as hard as stone.

Boiled linseed oil, litharge, red and white lead, mixed to a proper consistence, and applied on each side of a piece of flannel, or linen, (as the fittings may require a thicker or thinner substance) previously shaped to the joints, and then interposed between the pieces before they are "brought home" to their place by the screws, make a close joint. *Editor.*

ON THE APPLICATION OF MINERALOGICAL AND CHEMICAL SCIENCE TO THE SELECTION OF STONE, FOR THE PURPOSES OF DURABLE ARCHITECTURE.

From the Monthly Magazine, [London] of June, 1811.

THE remains of ancient architecture, which prove the greatness and splendour of states and governments that have long since ceased to exist, whilst they impress the mind with a melancholy conviction of the mutability of empire, excite also a kind of religious veneration for the edifices which have endured, amidst such great and various changes in human affairs, and have seen a long series of successive generations perish from the earth. When we compare these monuments of antiquity with the proudest structures of modern times, we are forced to acknowledge the superior skill, or science, with which the materials of the former were selected. Many of the most splendid works of our celebrated architects are hastening to decay, in what may be justly called, the very infancy of their existence, if compared with

the date of public buildings which remain in Italy, in Greece, in Egypt, and the East. This is remarkably the case with the three bridges of London, Westminster, and Blackfriars; the foundations of which speedily and visibly began to perish in the very lifetime of their founders. The destruction of ancient architecture has been chiefly occasioned by the ravages of wars, and the desolating hands of superstitious barbarians; the decay of modern buildings, is owing to the want of mineralogical science in the selection of the materials, by which they were sentenced to perish at an early date. None of them will rival in duration the temples of antiquity, and remain two thousand years, or more, after the ruin of the state, the august monuments of its former greatness. This may with certainty be predicted from the perishable nature of the stones of which they are built; they are rapidly decaying, and require constant renovation and repair.

Perhaps the following remarks on the selection of materials, for the construction of public buildings, may not be undeserving attention at this time, when two new bridges are to be built from London and its vicinity, to the southern side of the Thames. The most important quality in stone, for purposes of architecture, is durability, or the property of resisting the action of moisture, changes of temperature, vegetation, air, and light. It is also required, that the materials of bridges, and many public works, should be capable of resisting the effects of vibration and impulse. The most careless observer can scarcely have avoided noticing, that many kinds of stone decay much sooner than others. It is not only in stones of different kinds, that the power of resisting decay is variable; even in stones of the same kind, and brought from the same place, a considerable difference in this respect is found to exist; but the principles on which the proper selection of building-stone should be made, has been little understood or attended to. During a few months' residence in the metropolis, I was induced, by the nature of my mineralogical pursuits, to pay some attention to the different stones of which the pavements and public edifices are constructed. On walking into the

court of Somerset-house, after some weeks of dry weather, I was particularly struck with the appearance of the columns on the left hand, facing the west. The stones, in three columns, were some of them entirely coated with soot, when the stones above and below were perfectly white. In other parts, a white stone was between two black ones, and the division of colour as distinct as if the one had been painted white and the other black. These stones were all equally exposed, and the variation of colour could not be explained by their situation. At first I conceived, that this difference of colour might be occasioned by some substance entering into the composition of the black stone, that had a chemical affinity for ammonia, which is contained in soot; but, on examining some of the stones that were within my reach, I found that those which were covered with soot, had a hard, smooth, surface, and the white stones were evidently decaying. The particles on which the soot had fixed, were fallen off, and had laid bare the natural colour of the stone, as perfectly as if they had been recently scraped with a chissel. In other parts of the building, I observed the visible decomposition of the stone, by moisture, particularly in the upper part of the alto relievo figures.

This edifice, like most of the modern buildings in the metropolis, is constructed of Portland-stone; a peculiar kind of limestone, which I shall afterwards more particularly notice. It is evident, however, that this stone which is considered of the same kind, and comes from the same place, varies much in its property of durability.

When the same stone is constantly exposed to the action of water, the difference in its qualities of resisting decay is more apparent, as is evident from an inspection of London, Blackfriars, and Westminster bridges, at low water.* The best kind of Portland stone is ill suited to resist the decomposing effects of water, the two former of these magnificent bridges, constructed at so

* The stones of Westminster bridge appear to have been selected with more knowledge, as they are much less decayed than those of Blackfriars; the architect was a Frenchman.

much expense, are perishable monuments of the neglect of mineralogical science.

In stones of the argillaceous genus, more striking instances of rapid decay occur. I have seen stones of this kind, in their native beds, or quarries, some hundred feet under the surface of the earth, so extremely hard, that they resisted the point of the pick-axe, and could only be removed by blasting with gunpowder; yet, when the same stone was exposed to the air for a few months, it became soft and shivered into small pieces. The cause of this sudden decay, I shall afterwards explain. It rarely happens that builders or architects have any acquaintance with mineralogical and chemical science, to enable them to anticipate the changes which will be effected in the materials they select, by the action of the agents to which they are to be exposed. The loss and disappointment which this ignorance has occasioned in the construction of many public works, is well known. A remarkable instance of this kind lately took place at Paris. A gentleman was walking with an eminent mineralogist in one of the newly-erected public edifices; they were pleased with the appearance of some large columns in the interior; when the latter had examined them more closely, he predicted, from the nature of the stones, that they would perish in less than three years. About ten months after, the gentleman happened to pass the same place, and observed the stones of these columns were shivering so rapidly, that the workmen were then engaged in replacing them; which had become necessary to secure the roof. In forming the tunnel of the Huddersfield canal, which is three miles in length, the workmen in one part had to cut through a bed of stone of considerable extent, so hard that they were obliged to remove it by blasting. It appeared so compact and firm, that it was thought unnecessary to wall and arch the passage: but, in a few months after the access of air to it, it shivered and fell in; and the removal and repair occasioned much delay and expense. It was a dark compact argillaceous stone, containing oxyd of iron, and resembling some kinds of basalt; but its shistose or slaty structure was soon apparent, and it became as soft as the bituminous

shale which accompanies coal. Some kinds of stone become harder, by exposure to the atmosphere. An enquiry into the causes of decay in different kinds of stone, and also in stones considered of the same kind, may not be undeserving the attention of the public.

To ascertain these causes with precision, it will be necessary to attend, first to the external character of stones, and the qualities and proportions of the earths of which they are composed; and, secondly, to the decomposing or disintegrating effects of the agents to which they are to be exposed.

The four earths which form the principal part of all building-stones, are silex, or the earth of flint, clay, lime, and magnesia. The substances which sometimes enter into their composition, and alter their quality, are oxyd of iron, water, and carbonic acid: the other earths, or metals, are generally in too small quantities to deserve the attention of the architect. The qualities which these four earths communicate I shall afterwards state. The most important external characteristics of stone for building, are compactness of texture, hardness, degrees of frangibility, and specific gravity. Compact texture, or closeness of grain, is always an advantage in stones of the same kind; for it is evident, that a porous stone will be more exposed to the action of air, or moisture, than a denser one of the same kind: but compactness of texture is no test of excellence in stones of different kinds, for chalk is frequently more compact than many kinds of durable sand-stone. Hardness is also an important character in comparing varieties of the same species of stone, but it will not serve as a test of durability in stones of a different genus, on account of the different effects which different agents have upon them. The hardness of natural or artificial substances is no direct proof of their strength; glass, which is harder than iron, is more frangible than soft lime-stone. In compound stones, which have a crystallized texture, we frequently find the parts extremely hard, but the adhesion of the parts to each other very slight, as in some kinds of sand-stone.

Great specific gravity, or weight, is a proof of excellence in

stones of the same kind, unless it arise from a combination with water, or the presence of iron, which is a circumstance deserving great attention; as iron, when in combination with stones, is acted upon by air and water, which occasions their decay. Some basalts, which are extremely compact, ponderous, and hard, striking fire with steel, contain more than 25 per cent. of iron, and are soon decomposed at the surface, when exposed to the atmosphere. In general, specific gravity, where it does not arise from the absorption of water, and the presence of iron, or other metallic earths, may be considered as a quality indicating excellence for purposes of architecture. No stones, except those which contain the earth of strontian, or barytes, weigh three times as heavy as an equal bulk of water, unless they are combined with some metallic substance, which is generally iron. The specific gravity of few stones, except foreign marbles, exceeds 2.80, unless some iron be present.

The quality of the three earths, silex, clay, and lime is essentially distinct; but there are scarcely any stones that can be employed in architecture, in which they are not more or less combined together; communicating their character according to the proportion in which they combine. Hardness is a distinctive character of stones, into which silex enters in a very large proportion. Silex being insoluble in water, and all the acids, except one of rare occurrence, silicious stones are, of all others, the most durable, and best suited for the foundation of bridges, piers, and docks. Silicious stones are frequently compounds, containing two, three, or more, substances, united together in a granular or crystallized form.

Granite is composed of quartz, felspar, and mica. The quartz contains more than ninety parts of silex, the felspar sixty, and the mica, which is generally in the smallest proportion, about forty. The grains, or crystals, though distinct, are as firmly imbedded and united to each other, as if they had been melted together. Granite is not only extremely hard, but is also very infrangible, resisting the effects of violent percussion. Some kinds of porphyry, which contain crystals of felspar, imbedded in a sili-

cious base, are as hard, and still less frangible than granite. In silicious sand-stones, the coarseness or fineness of the grains is of less importance than the substance in which they are imbedded. Those which have a basis of ferruginous clay, are soft and perishable; but when the basis itself is of a silicious kind, the stones are almost equally durable with granite. The upper strata of many of the highest hills in Yorkshire and Derbyshire, are of this kind, which Mr. Whitehurst calls a mill-stone grit. It is of a finer-grained stone, of the same kind that Kirkstall Abbey, near Leeds, is built. Though the Abbey is a ruin, the stones which remain are little decayed. After the lapse of six hundred years, they preserve their angular sharpness, and the impression of the chissel, as fresh as if they had been recently worked. There is a quarry of this stone in the neighbourhood; and I have observed some of the stones in the London docks, are of a similar kind. Some silicious sand-stones appear to be of alluvial formation, and have their parts so imperfectly cemented, that they are unfit for the purposes of architecture; of this kind are the rocks on which the town of Nottingham is built; and the red-sand rock of Cheshire. The former may be considered more properly as indurated gravel, intermixed with rounded quartz pebbles; but, though it is too loose to be applied to purposes of architecture, it may be excavated to a considerable extent, without the necessity of supporting the sides and roof. The granite of Charnwood forest, and the loose sand-rock of Nottingham, are not more than twenty miles distant, but they may be considered as forming the two extremities of the scale of aggregate silicious stones, from the very hardest to the softest kind. Argill, or clay, is never found pure in any kind of building-stone. It is soft, smooth, and unctuous to the touch, and will absorb more than $2\frac{1}{2}$ times its own weight of water; and, as Mr. Kirwan has observed, it communicates, in some degree, these properties to stones, if it is combined in a proportion of from 20 to 30 per cent. In a greater proportion it destroys the qualities of silicious stones. Many argillaceous stones contain a considerable quantity of iron, not perfectly oxydated. When exposed to the atmosphere, they

speedily decay. It is in stones of the argillaceous kind, that the greatest caution and mineralogical knowledge are required, in the selection for purposes of durable architecture. I have seen a hillock at the mouth of a lead-mine, supporting a luxuriant vegetation, which a respectable miner informed me he had twenty years before blasted from a compact bed of toad-stone, or basalt, that resisted the pick-axe, and no soil had been since thrown upon it. An instance of this kind was the occasion of an action at the last York assizes, between the proprietors of the Barnsley canal, and the engineer. On the part of the proprietors it was contended, that the hill through which he had to cut a tunnel, was a soft marble. On the part of Mr. Pinkerton it was stated, that, though the part exposed was now soft, it was, when first opened, a very hard and compact rock, extremely expensive and difficult to work; and the truth of this statement he offered to prove, by perforating any part of the hill where the stone had not before been laid bare to the action of the atmosphere. The argillaceous sand-stone which accompanies or lies over coal, is used for buildings in coal countries, as in some parts of the West Riding of Yorkshire; but it is not suited for public buildings, or works intended to be durable. Stones of the calcareous genus, comprise all the various marbles and limestones. These are generally more free from admixture with other earths, than stones of the silicious, or argillaceous kind; and their relative degrees of excellence for purposes of architecture, are more easily ascertained by their external character. Besides pure lime, they contain from 45 to 50 per cent. of carbonic acid and water. Lime when pure is soluble in five hundred times its weight of water; and, even when united with carbonic acid, it is in a less certain degree soluble in river waters, owing to the minute portion of different acids, which is generally contained in them. On this account they are ill suited to form the foundations and piers of bridges, or to be employed in the construction of works exposed to the action of the water. The durability of marbles and lime-stones might, I believe, with some certainty be determined by their relative degrees of hardness, and by observing the time

required to dissolve an equal cube of each kind of stone in marine acid, of the same strength, diluted with five times the quantity of water at the same temperature. The sediment remaining will also determine the quantity of silex or clay with which the lime is combined. Magnesia enters into the composition of some lime-stones in the proportion of two-fifths, and renders the softest stones of this kind less soluble in acids than the hardest marbles, on which account it will be necessary to ascertain by chemical experiments, whether the slowness with which lime-stone is soluble, proceeds from the presence of magnesia; but I believe it will also be found that a mixture of this earth, where it occurs in lime-stone, not only renders it less soluble in acids, but communicates to it a degree of durability which is not to be found in other lime-stones of the same degree of hardness. The high comparative degree of preservation observable in the exterior of York Minster, and other public edifices which are built of this stone, may serve to prove its excellence for purposes of architecture.

Portland stone is a peculiar kind of lime-stone, which some mineralogists call roe-stone. When examined with a magnifying lens, it will be found to contain a number of small round globules, resembling in appearance the roes of fishes, imbedded in a calcareous basis, from whence it derives its name. It also contains fragments of shells, and minute calcareous crystals. It varies in its qualities of hardness and compactness, and in its properties of durability, as may be observed in many of the public edifices in London, which are built of this stone. In the construction of St. Paul's, some attention appears to have been paid to the selection of the stones for the exterior, which are more perfect than those in many buildings of a recent date; but they are evidently perishing in the upper part of this magnificent structure.

Portland stone contains carbonate of lime, united with a small portion of silex and clay. Its solution in diluted muriatic acid gives a dark-blue precipitate, with the Prussian alkali, indicating the presence of oxyd of iron, to which it owes its brownish tint;

but the quantity of iron is too small to affect its quality for the use of the architect. It burns to a white lime, losing more than eight parts in twenty of its weight, during calcination. According to professor Jameson, roe stone is never used for architecture, on account of its speedy disintegration; but his observations appear to have been confined to the varieties of this stone in Germany, and inapplicable to those in our own island. Two stones called by the same name, from different situations, are seldom exactly similar in all their properties; which indeed rarely happens with stones from different layers of the same bed. And where strata of calcareous stone are separated by other kinds of stone, the upper and lower strata, almost invariably differ in hardness and specific gravity; on which account it would be very desirable, that a mineralogical examination of stones should be made in their native quarries, and that those which are intended for the external part of buildings, should be judiciously selected from the others. Of all stones of the calcareous genus, there cannot be a doubt that compact marbles, which can receive the highest degree of polish, would be the most beautiful and durable for the exterior of buildings; but their scarcity in this country prevents their application to this purpose. Alabaster, which is composed of lime, united with sulphuric acid, from its beauty and the facility with which it can be worked, is used for ornamental architecture and sculpture; but the solubility of this stone renders it ill-suited to resist the agency of water.

Dr. Watson relates, that he suspended two ounces of this stone in a pail of water for forty-eight hours, changing the water several times, and found that it had lost one-thirtieth part of its weight. I suspect this alabaster was one of the softest kind; but the experiment may serve to show, that this stone will not bear exposure to rain. There are no other stones deserving the attention of the architect, but those of the silicious, argillaceous, and calcareous genus, in the latter of which we may class magnesian lime-stone, the only building stone into which magnesia enters in any considerable proportion.

The decomposing and disintegrating agency of water, air, and

change of temperature, on stones employed in architecture, is the same by which nature is constantly operating to convert solid rocks into soil. The fiat of Omnipotence "commands the hardest stones to be made bread," or to become the means of supporting vegetable and animal life, but the processes by which this effect is produced, are slow and gradual. The earths of which all stones are composed, are either to a certain degree soluble in water, or are capable of being mechanically suspended in it when minutely divided. A drop of water, constantly running across the hardest stone, soon marks its path, by cutting a furrow in the surface; hence the well-known adage "Non vi sed sæpe cadendo." This effect, however, is slow, compared with that of other causes, which are constantly operating. Water insinuates itself into the pores and minute crevices of stones, and being expanded by increase of temperature, separates the parts from each other, but it produces this effect in a much greater degree when expanded by freezing. Frost is the most potent agent by which Nature operates 'en masse,' frequently splitting the hardest rocks, and levelling immense portions of mountains in a single night. In building stones which have a tendency to a slaty structure, the destroying effects of frost are most likely to be soon perceptible, from the facility with which water can insinuate itself between the lamina. In stones of the argillaceous genus, the joint effects of water and air frequently produce a speedy decomposition, even of those of the hardest kind. If a stone have a strong earthy smell, when breathed upon, its durability may be suspected. Iron frequently enters in large proportions into argillaceous stones, in a state not perfectly oxydated, and afterwards combines with a further portion of oxygen, forming a brown incrustation to a certain depth, which becomes soft and falls off, or is washed away, and the process of decomposition goes on till the whole stone is changed. The argill, or clay, in these stones, is also frequently capable of absorbing a greater portion of water; and the stone may be rendered soft by the combined operation of these two causes. It is in these stones that the different earths are com-

bined, in the proportions best suited to the support of vegetable life.

Lichens and mosses fix themselves on the surface of stones, and, by insinuating the minute fibres of their roots, tend to accelerate their decay and prepare a vegetable mould for plants of a larger growth. The decomposition of many argillaceous stones, which are most necessary for the support of vegetable life, is most speedily effected by natural causes; hence, more caution and skill are necessary in their selection for architecture. No stones of this genus should ever be employed, which have not had the test of time, without a careful mineralogical and chemical examination of their nature and contents. This examination would always precede the application of stones for public works or edifices, intended to endure for ages, were engineers and architects as attentive to their future fame, and the interests of posterity, as to present emolument. Besides the chemical examination of stones, it is necessary to try the effect of various degrees of heat, and of boiling water, upon them, applied for a considerable time, and to note carefully their increase or loss of weight, and other changes. In this manner we may sometimes anticipate with certainty, in a few days, what will be the effects of less powerful, but long-continued natural operations in a series of years. For purposes of durable architecture, no stones but those of the silicious genus should be employed in the exterior parts of buildings. In our moist and variable climate, all kinds of stone but the silicious will perish sooner than in countries where the rains are less frequent. The present state of our churches and public buildings proves that the selection of building stones has been left to ignorance or chance to determine. The ancients, in their public works, appear to have had a just regard to perpetuate the glory of the era in which they lived, and to leave to posterity durable and useful monuments of their skill, which should secure their gratitude and veneration. The public architecture in this country appears constructed on calculations of false economy and present convenience, with little regard to the benefit of future generations.

Granite and porphyry, on account of their extreme hardness, are difficult to work; but they would well repay the expense for bridges and public buildings. It was of these stones that the Egyptians, and other nations of antiquity, constructed palaces and temples, which have endured the attack of time and the desolating hand of superstitious barbarians. The origin of some of these structures is prior to the oldest records of man, and they will exist when no vestige of the architecture of modern times shall remain.

ROBERT BAKEWELL.

Warwick Court, Gray's Inn.

For the Archives of Useful Knowledge.

ON MAKING OPIUM.

Williamsburg, Virg. 9th Aug. 1811.

SIR,

OF the time you devote so successfully to the progress of the Arts and Sciences, give me leave to request you will bestow a small portion, to the examination of some imperfect experiments to ascertain the practicability of making opium in this country. Specimens of what I have made, will be forwarded to you by my friend Mr. Williams, from which you will be enabled to judge of my success.

EXPERIMENT I.

On the 19th of June last, I pounded in a marble mortar 3 lbs. 9 1-2 oz. of leaves and stems of poppies (*papaver somniferum*): I pulled off the capsules, and saved the seed, to make that kind of oil known in France by the name of *huile d'oillete*; the leaves and stems had been gathered for two days; and although kept in the shade, were much withered. I minced them very small, and pounded them to a soft pulp, adding by little and little four pints of water. I added also to the residuum so pounded, two quarts of warm water; and let it stand one hour; after that, I threw the whole mass into an iron pot, with warm water (one gallon); I boiled it half an hour, the better to loosen the fæcula;

I strongly strained* this decoction, and put it again in the iron pot: the day after, I clarified this juice with the whites of two eggs; and while warm, I filtered it through a strong cloth, and poured it into five large flat dishes to evaporate in the sun. The same day I washed with cool water, the skimmings and the residuum obtained from the clarification above-mentioned. I took off the coarsest parts, and put the subsiding ones to evaporate in the sun. The 26th, after five days of evaporation, by which time it was almost reduced to a state of friability, I weighed it, and obtained 3 1-2 drachms and 1 scruple.

July 7th. I weighed the extract of the 3 lbs. 9 1-2 ounces of leaves and stems, clarified the 20th June; it weighed 3 oz. 2 drachms: that extract was very black, and very deliquescent, although it had been during 18 days in the sun, which shone without intermission, and produced great heat during the whole time (92 and 93 degrees Fahrenheit). I even observed that this extract softened by the coolness of the night. Moreover, it required half the time to become hard, that was necessary for the extract which I had not clarified, of which I will speak hereafter.

July 24th. Finding that this extract became more and more deliquescent, I determined to try the following *manipulation*. I pounded the leaves of poppies, which were previously dried in the sun and in the shade. I sifted the powder, and incorporated it by little and little with the extract; and succeeded in making a solid mass, which weighed 4 oz. 4 drs. instead of 3 oz. 2 drs. as before. Consequently it required 1 oz. 2 drachms of powder, to make it consistent.

I was induced to make this mixture of powder, by finding, on examining a piece of Turkish opium, with my magnifying glass, that it contained a large parcel of fæcula† of vegetables, and other

* It is, I suppose, perfectly useless to point out the inconveniencies of having no press to squeeze all the juice from the husk, and it is certain that I lost a great deal of juice in straining by the hand.

† The word *detritus* which I dared not to use, would express more clearly my idea, than the word *fæcula*. The word *detritus*, has been long since adopted by the French, and is worthy of admission into the English language. It

impurities, which I suppose to be derived from the poppies. I wished also to ascertain by the result, if the extract prepared in that way is stronger. Dr. Stork says, that the extract of hemlock prepared with the powder of hemlock, operates more powerfully than that prepared without the powder.*

EXPERIMENT II.

On the 26th and 27th of June last, I pounded 22 1-2 lbs. of leaves, stems, and capsules, of the same poppies, which were gathered on the morning of the 26th. I threw the whole mass as soon as it was well bruised into an iron pot full of water: the 27th, I boiled about one-third of it, and caused it to be pressed by two very strong persons,† through a new cloth, but not very hard. I had five quarts and $1\frac{1}{2}$ pint of juice. I boiled another third part, being previously soaked during six hours. I obtained five quarts one pint of juice. The remaining part, treated in the same way, gave only four quarts one pint of juice. I put the first five and three-fourth quarts in five very broad shallow dishes, to evaporate in the sun: the remainder was evaporated over a water bath; and after that, the first five and three-fourth quarts, which I tried first to evaporate in the sun, in order to dry it sooner.

July 7th. I weighed all the extract I obtained from the 22 1-2 lb. of poppies. On one side, I obtained 11 oz. 2 drs. of a dry and very consistent extract, which I brought to a state of perfect exsiccation upon shelves. On the other side, I obtained 7 oz. 1 dr. of an extract very soft, and which dried with great difficulty, and very slowly, although it was exposed, like the first

is derived from the Latin, *deterere, detero, detrivi, detritum,* and signifies to break, to cut in pieces, and would better express the idea of those parts of vegetables, which are cut in pieces, or destroyed mechanically or naturally, than the word *fœcula,* which means only the dregs or fæces, which subside from vegetable juices.

* See, on that subject, what Beaume says in his Elements of Pharmacy, 8vo. edition 1797, Art. *Extrait de Cigue Préparé suivant la méthode de Dr. Stork.*

† This relates to the first Note, and the loss I sustained in the straining of the juice for the want of a strong press.

parcels, to a very intense sun, after having been evaporated by the water bath, a difference I cannot account for, unless it was, because this last was too long upon the fire, from which it acquired a strong burnt smell, which it lost by exposure to the air.

With respect to this last extract, I must observe, that, finding on the 24th of July, notwithstanding all my trouble to bring it to the same consistency as that of the first, it was always soft and deliquescent, I was induced to mix also with it some powder of poppy leaves. I succeeded in making it a little hard with three drachms thereof; and instead of 7 oz. 1 dr. which it weighed before, it weighs now 7 oz. 4 drs.

From the general result, it is seen, that 22 1-2 lbs. of poppies have afforded 1 lb. 2 oz. 3 drs. of opium (I do not reckon the three drachms of powder incorporated in the last extract) which experience alone can prove to be as good, if not superior to Turkish opium (*Note I.*):* if so, no doubt remains, but that the culture of poppies may become a very profitable branch of agriculture in this country; and so much the more, as poppies grow spontaneously in every land, and require almost no trouble or management at all. Besides the making of opium, the poppy seeds afford a very good oil, known in France by the name of oil of poppy, or *huile d'oillete*, which is extracted in the way of the oil of rape, linseed, &c. and may supply, in many respects, the oil of olives, or sweet oil (*Note II.*)* I will speak hereafter of some experiments I have made upon the extraction of that oil.

Considering all the advantages afforded by this plant, I am inclined to class it among the most useful productions of this country; and I believe we might say to the industrious men who would follow, in a large way, this branch of industry—*Vestitum, victum, et laudem hinc sperate coloni.*

EXPERIMENT III.

I will now proceed to speak of some experiments I have made to ascertain the possibility of making opium from lettuce, *lactuca sativa.* I confess I am indebted to Dr. Redman Coxe, the editor of the American Dispensatory, for the first hint on that sub-

* See close of the article.

ject. In consequence, it is to him I beg leave to make the homage of my successful experiments on that plant. I hope he will accept it with kindness, and be so good as to give me his opinion on the opium thence obtained.

On the 10th of June last, I pounded in a marble mortar eight plants of lettuce, (*lactuca sativa*), which were almost in blossom. I strained the juice, and put it in two large and almost flat dishes to evaporate in the sun. After three days, I obtained 7 drachms of an extract of a greenish hue, with a very strong smell of the fæcula of green plants, which smell it lost in two or three days; and became also of redish-brown hue. By this simple process is discovered the very little trouble required in the preparation of this opium, which I suppose may be brought to perfection by a more accurate manipulation. We also see how profitable may become the culture of lettuces, in a large way, since eight plants have afforded by the most simple process, seven drachms of opium. Above all, as Dr. Coxe observes so judiciously, "the opium is procured after the period in which the plant is useful for the table."

I mentioned that I would relate the experiment I have made on the extraction of the oil of poppy. This is the result. The 30th of July I caused to be pounded in an iron mortar 4 1-2 oz. of poppy seed, which were the produce of the capsules I saved from the 3 lb. 9 oz. of leaves and stems, employed in my first experiment. These seeds being well pounded, and almost reduced to a paste, by means of a little water, I threw the whole mass into an iron pot full of boiling water, and boiled it half an hour. When that water was cool, I perceived only a few small particles of light oil, and so difficult to collect, that it could not be taken out with a flat spoon, as is done with castor oil, but mixed with much water; I tried to separate the oil from the water, with a filtering cotton wick; but I could not succeed. Then, in order to ascertain that there were some oily parts in the mixture, I poured into three ounces of that water, 6 oz. of *lixivium causticum*. I obtained a soapy matter, which hardened more and more

by loosing its water of composition, and diluted with water washed the hands perfectly clean.

That experiment induces me to believe, that this oil cannot be extracted but in the way, and by the process for extracting the oil of rape, linseed, &c. &c.*

How imperfect soever may be these experiments, I hope, sir, you will consider them as the result of the few moments I can spare from my mercantile business, to devote to my own instruction, and to public utility. Whatever use you may make of them, I beg leave to tell you, that I wish to be perfectly unknown, and that long since, I took for my motto, *mea mediocritate me involvo.*

I am, sir, with the greatest consideration,

Your most humble and obedient servant.

DR. JAMES MEASE.

(*Note* 1.) But till experience shall pronounce in that respect, I must observe, that the approbation which this opium has obtained from doctor Tazewell, an eminent practitioner in this city, has great weight with me. After a very minute examination of the extract, he confessed, it was equal to any opium he had ever used. I gave him 1 oz. 2½ drams of the extract, intreating him to try it upon some of his patients, and communicate the result of his experiments: I subjoin his letter.

"*Williamsburg, 5th Aug.* 1811.

"Dear Sir,

"Your experiments on the extraction of opium from the poppies of Virginia, while they do honour to yourself, may prove highly beneficial to your adopted country. It is to the labours of men like yourself, who bring with them from their native country a willingness to communicate their knowledge to others,

* For the process of extracting this oil, and in general what they call oil of seed, see what the Abbe Rosier says in his Cours complet d'Agriculture, &c. &c. word *huile*, chap. 2, sect. 3 and 4. The description of the machines, and other contrivances, and the process adopted in that way by the Dutch, related by that eminent agriculturalist, may, I suppose, be very useful in this country.

added to the native genius of the country, that the arts and sciences owe their rapid progress in America.

"Since the 20th ultimo, when you did me the favour to present me with a specimen of your American opium, I have had occasion to use it in a few cases of diarrhœa, one of colic, and one of toothach. It gives me great pleasure to state to you, that in those trials, its happy effects have answered my most sanguine expectations, insomuch that I hesitate not to pronounce it fully equal to any opium I have ever used.

"With esteem, yours,

"Signed, W. TAZEWELL."

I ought also to mention, that the late doctor Bates, of James' City county, never used in the course of a long practice, any other opium than such as he made himself, from the poppies of this country; and he often said, he never used better.

I have been told too, by many, that doctor Griffing, sen. still living in York-town, made, in the revolutionary war, opium from the poppies of this country, and never used any other in his practice. As that gentleman is still living, I hope I shall hear from himself, the truth of that assertion.

I must mention also, that wishing to know from my own experience, whether this opium possesses the sedative virtues, and of mitigating pain, like the common opium, I put in a 5 oz. phial, 2 drams of it, previously cut in small pieces, upon which I poured 4 oz. (by measure) of strong West India rum, and 1 oz. (by measure) of camphorated spirit of wine. I hung the phial in the sun: in three days the solution was completed. For three weeks past, I suffered from a violent pain in my right hip, of the sciatic kind, which often rendered me unable to rise from my chair: in the evening of the 26th July, I began to rub my back with that solution, and I slept very well that night; in the morning I felt a great deal better, and in two days, I was relieved from the painful state in which I had been for three weeks.

(*Note* 2.) As some persons may conceive suspicions or prejudices against the qualities of this oil, I will endeavour to remove

them, in quoting what the Abbe Rosier says in his *Cours complet d'Agriculture theorique, pratique, &c. &c.* on the word *pervot*, chap. 3: "The oil they extract from the poppy, called oil of oillete, is sweet, agreeable, and smells like the hazlenut; it does not freeze even at 10 and 15° (of Reaumur); it contains a great deal of fixed air: in a word, after what is called the finest oil of olives, it is the best and most agreeable for dressing any kind of victuals boiled, or in condiments; its only bad quality is not to burn well in a lamp: of all the known oils, this is the best to take off the bad and rancid smell of oil of olives." "Who can believe, exclaims he after, that an oil so wholesome, so sweet, was prohibited in France during a long period of time? It was about the year 1715 or 1716, that they conceived and reported some suspicions on the qualities of this oil. Complaints were made to the lieutenant-general of the police; that magistrate took, in 1717, the advice of the medical society of Paris, who in the same year appointed some commissioners to proceed to the strictest and most scrupulous examination of the qualities of that oil. The experiments were made in presence of more than 40 doctors, convened for that purpose. They informed the magistrate, that the oil contained nothing unwholesome. *Cum sensuissent*, say the records of the faculty, *doctores nihil narcotici aut sanitati inimici in se continere, ipsius usum tolerandum esse existimarunt.* The Abbe Rosier, says again, "that the 12th February, 1774, the medical society issued another decree, which confirms that of 1717; and the college of physicians of Lille, in Flanders, where the consumption of the pure oil of poppy is common, issued a like decree the 16th of September, 1773." After such authorities, I suppose, there cannot exist the least prejudice against the use of this oil.

REMARKS.

In compliance with the wish expressed, the Editor forbears to publish the name of his correspondent. The experiments related are satisfactory, and there can be no reasons for supposing that

the opium made from poppies growing in any country, will not be as powerful as that imported from Turkey or the East Indies.

Opium has been prepared from the true opium poppy, (papaver album) or white poppy, and the common poppy of our gardens, in several of the United States, even as far north as New Hampshire; and upon trial, has been found equally powerful as the opium imported from the Levant or the East Indies. In the southern states, now that cotton and rice, and tobacco, are scarcely saleable, the planters could not apply a portion of the labour of their slaves to a more profitable account, than by the cultivation of the poppy, among *several other articles*, to which their attention might be directed. Opium is now worth $7 per lb. and has been as high as $14, in the course of the last three years. In the next number of the "Archives," the Editor will give the result of the experiments upon the poppy plant in the United States, and in England, for the encouragement of those who choose to begin the culture of that important vegetable.

The wholesome quality of the oil of the poppy seed, has long been known, and has been recently proven extensively in Europe. Dr. Cogan, of England, and Mr. Van Eys, of Amsterdam, have both written on the subject: an abstract of their publications, shall be given in the next number of this work. *Editor.*

AN ANALYSIS OF

SEVERAL VARIETIES OF BRITISH AND FOREIGN SALT, (MURIATE OF SODA) WITH A VIEW TO EXPLAIN THEIR FITNESS FOR DIFFERENT COMMERCIAL PURPOSES.

By WILLIAM HENRY, *M. D. F. R. S. V. P. of the Lit. and Phil. Society, and Physician to the Infirmary of Manchester.*

From the Philosophical Transactions of the Royal Society of London.

SECTION I.—*General observations.*

IN undertaking the series of experiments described in the following pages, I had not so much in view the discovery of novelties in science, as the determination, by the careful employment

of known processes, and by the improvement of methods of analysis, of a number of facts, the establishment of which (it appeared to me probable) might have an influence on an important branch of national revenue and industry.

An opinion has for some time past existed, and I believe has been pretty general both in this and other countries, to the disadvantage of British salt as a preserver of animal food; and a decided preference has been given to the salt procured from France, Spain, Portugal, and other warm climates, where it is prepared by the spontaneous evaporation of sea water. In conformity with this opinion, large sums of money are annually paid to foreign nations, for the supply of an article, which Great Britain possesses, beyond almost any other country in Europe, the means of drawing from her own internal resources. It becomes, therefore, of much consequence to ascertain, whether this preference of foreign salt be founded on accurate experience, or be merely a matter of prejudice; and, in the former case, whether any chemical difference can be discovered, that may explain the superiority of the one to the other.

The comparative fitness of these varieties of salt for the curing of provisions, which has been a subject of much controversy among the parties who are interested, can be decided, it is obvious, in no other way, than by a careful examination of the evidence on both sides. Where evidence, however, is doubtful, and where there exists, as in this case, much contrariety of testimony, it cannot be unfair to yield our belief to that, which best accords with the chemical and physical qualities of the substances in question. Again, if salt of British production should be proved to be really inferior in chemical purity to foreign salt, it would be important to ascertain, as the basis of all attempts towards its improvement, in what, precisely, this inferiority consists. It seemed desirable, also, to examine whether any differences of chemical composition exist among the several varieties of home-made salt, which can explain their variable fitness for economical purposes.

Such were the considerations that induced me to undertake an

inquiry, which had occupied, for several months past, a large share of my leisure and attention. I began the investigation wholly uninfluenced by any preconceived opinions on the subject; and I had no motive to see the facts in any other than their true light, since I have no personal interest, either directly or remotely, in the decision of the question.

The principal sources of the salt which is manufactured in this country, are rock salt, brine springs, and sea water. The first material is confined entirely, and the second chiefly, though not wholly, to a particular district of Cheshire. Of the extent and boundaries of this district, the process of manufacture, and other circumstances interesting to the mineralogist as well as to the chemist, an ample and excellent history has been given by Mr. Henry Holland, in the Agricultural Report of the county of Chester.* From his account I shall extract, in order to render some parts of this memoir more intelligible, a very brief statement of the characteristic differences of the several varieties of salt, which are prepared in Northwich and its neighbourhood.

In making the *stoved* or *lump salt*, the brine is brought to a boiling heat, which, in brine fully saturated, is 226° of Fahrenheit. This temperature is continued during the whole process; and as the evaporation proceeds, small flakey crystals continue to form themselves, and to fall to the bottom of the boiler. At the end of from eight to twelve hours, the greatest part of the water of solution is found to be evaporated; so much only being left, as barely to cover the salt and the bottom of the pan. The salt is then removed into conical wicker baskets, termed *barrows*; and, after being well drained, is dried in stoves, where it sustains a loss of about one-seventh of its weight.

On the first application of heat to the brine, a quantity of carbonate of lime, and sometimes a little oxyd of iron, both of which had been held in solution by an excess of carbonic acid, are separated; and are either removed by skimming, or are allowed to subside to the bottom of the pan, along with the salt first formed, and with sulphate of lime; and are afterwards raked out. These

* Published in 1808.

two operations are called *clearing* the pan. Some brines scarcely require them at all, and others only occasionally. The whole of the impurities, however, are not thus removed; for a part, subsiding to the bottom, forms a solid incrustation, termed by the workmen *pan-scale*. The portion of this, which is lowest, acquires so much induration and adhesion to the pan, that it is necessary to remove it once every three or four weeks, by heavy blows with a pick-axe. These sediments are formed, also, in making the other varieties of salt.

In preparing *common salt*, the brine is first raised to a boiling heat, with the double view of bringing it as quickly as possible to the point of saturation, and of clearing it from its earthy contents. The fires are then slackened, and the evaporation is carried on for twenty-four hours, with the brine heated to 160° or 170° Fahrenheit. The salt, thus formed, is in quadrangular pyramids or hoppers, which are close and hard in their texture. The remainder of the process is similar to that of making stoved salt, except that after being drained, it is carried immediately to to the store-house, and not afterwards exposed to heat, an operation confined to the stoved salt.

The *large-grained flakey salt* is made with an evaporation conducted at the heat of 130 or 140 degrees. The salt thus formed is somewhat harder than common salt, and approaches more nearly to the cubic shape of the crystals of muriate of soda.

Large grained, or *fishery salt*, is prepared from brine heated only to 100° or 110° Fahrenheit. No perceptible agitation, therefore, is produced in the brine, and the slowness of the process, which lasts from seven or eight to ten days, allows the muriate of soda to form in large and nearly cubical crystals, seldom, however, quite perfect in their shape.*

For ordinary domestic uses, stoved salt is perfectly sufficient. Common salt is adapted to the *striking* and salting of provisions, which are not intended for sea voyages or warm climates. For the latter purposes, the large grained or fishery salt is peculiarly fitted.

* Cheshire Report, p. 53, &c.

On the eastern and western coasts of Scotland, and especially on the shores of the Frith of Forth, large quantities of salt are made by the evaporation of sea water. In consequence of the cheapness of fuel, the process is carried on, from first to last, by artificial heat, at a temperature, I believe, equal, or nearly so, to the boiling point, and varying, therefore, according to the concentration of the brine. The kind of salt, chiefly formed in Scotland, approaches most nearly to the character of stoved salt. In some places a salt is prepared, termed *Sunday salt;* so called, in consequence of the fires being slackened between Saturday and Monday, which increases considerably the size of the crystals.

At Lymington in Hampshire, advantage is taken of the greater heat of the climate, to concentrate the sea water by spontaneous evaporation to about one-sixth its bulk, before admitting it into the boilers. One kind of salt is chiefly prepared there, which most nearly resembles in grain the stoved salt of Cheshire. The process varies a little, in some respects, from that which has been already described. The salt is not fished (as it is termed) out of the boiler, and drained in baskets; but the water is entirely evaporated, and the whole mass of salt taken out at once, every eight hours, and removed into troughs with holes in the bottom. Through these it drains into pits made under ground, which receive the liquor called *bittern* or *bitter liquor*. Under the troughs and in a line with the holes, are fixed upright stakes, on which a portion of salt that would otherwise have escaped, crystallises and forms, in the course of ten or twelve days, on each stake, a mass of sixty or eighty pounds. These lumps are called *salt cats*. They bear the proportion to the common salt, made from the same brine, of 1 ton to 100.

From the mother brine or bitter liquor, which has drained into the pits, the sulphate of magnesia is made during the winter season, when the manufacture of salt is suspended, in consequence of the want of the temperature required for the spontaneous evaporation of the sea water. The process is a very simple one.*

* I am indebted for an account of this process, as well as of the method of making common salt at Lymington, to the liberal communication of Charles

The bitter liquor from the pits is boiled for some hours in the pans, which are used in summer to prepare common salt; and the impurities, which rise to the surface, are removed by skimming. During the evaporation, a portion of common salt separates; and this, as it is too impure for use, is reserved for the purpose of concentrating the brine in summer. The evaporated bitter liquor is then removed into wooden coolers eight feet long, five feet wide, and one foot deep. In these it remains twenty-four hours, during which time, if the weather prove clear and cold, the sulphate of magnesia, or Epsom salt, crystallises at the bottom of the coolers, in quantity equal to about one-eighth of the boiled liquor. The uncrystallisable fluid is then let off through plugholes at the bottom of the coolers; and the Epsom salt, after being drained in baskets, is deposited in the store-house. This is termed *single* Epsom salts, and after solution and a second crystallisation, it acquires the name of *double Epsom* salts. Four or five tons of sulphate of magnesia are produced from a quantity of brine, which has yielded 100 tons of common, and one ton of cat salt.

On the banks of the Mersey, near its junction with the Irish Channel, the water of that river before evaporation is brought to the state of a saturated brine, by the addition of rock salt. The advantage of this method of proceeding will be obvious, when it is stated, that 100 tons of this brine yield at least 23 tons of common, salt, whereas from the same quantity of sea water, with an equal expenditure of fuel, only two tons 17 cwt. of salt can be produced.*

St. Barbe, Esq. of that place. Though not strictly connected with the subject, I give his description of the mode of making Epsom salt, because no correct statement of the process has, I believe, been hitherto published. The analysis of sea water, indeed, by a justly-distinguished chemist (Bergman), excludes, erroneously, the sulphate of magnesia from its composition; and his results have led to the opinion, that to manufacture this salt on the large scale requires the addition either of sulphuric acid, or of some sulphate of the *bitter liquor*. (See Aikin's Chemical Dictionary, II. 388.)

* See the Earl of Dundonald's "Thoughts on the Manufacture and Trade of Salt." London, 1785.

Within the few past years, an attempt has been made to apply rock salt itself to the packing of provisions. For this purpose it is crushed to the proper size between iron rollers. The trials which have been made, I am informed, are but few, and the results hitherto are not perfectly known.

The *bay salt* imported from foreign countries is well known to be prepared by the spontaneous evaporation of sea water, which, for this purpose, is confined in shallow pits, and exposed to the full influence of the sun and air. I have no addition to make to the accounts of its manufacture, which have already been given by various writers.*

Section II. *General Statement of the Results of the Experiments and Conclusions that may be deduced from them.*

A comparison of the component parts of British and foreign salts, and of different varieties of British salt with each other, will best be made by an examination of the following table, which comprehends the results of the analysis of equal weights of each variety.

		1000 parts by weight consist of								
	Kind of Salt.	Insol. matter.	Muriate of lime.	Muriate of magnesia	Total earthy muriates.	Sulph. of lime.	Sulph. of magnesia	Total sulphates	Total impurities.	Pure muriate of soda.
Foreign bay salt.	St. Ubes	9	a trace.	3	* 3	23½	4½	28	40	960
	St. Martin's	12	do.	3½	* 3½	19	6	25	40½	959½
	Oleron	10	do.	2	* 2	19½	4½	23¾	35¾	964¼
Brit. salt from sea water	Scotch (common)	4	—	28 or *	28 or *	15	17½	32½	64½	935½
	Scotch (Sunday)	1	—	11½	11½	12	4½	16½	29	971
	Lymington (com.)	2	—	11	11 or *	15	35	50	63	937
	Do. (cat)	1	—	5	5	1	5	6	12	988
Cheshire salt.	Crushed rock	10	0·1/16	0·3/16	0¼	6½	—	6½	16¾	983¼
	Fishery	1	0·¼	0·¾	1	11½	—	11½	13½	986½
	Common	1	0·¼	0·¾	1	14½	—	14½	16½	983½
	Stoved	1	0·¼	0·¾	1	15½	—	15½	17½	982½

* Encyclop. Method. art. *Salina.* (Des Marais Salans) Aikin's Dictionary of Chemistry, ii. 224. Watson's Chemistry, vol. ii. p. 52. It is necessary to remark, that a great proportion of what is sold in London as bay salt, is Cheshire large-grained fishery salt.

I. The *total amount of impurities*, and the *quantity of real muriate of soda*, contained in each variety of common salt, may be learned by inspecting the two last columns of the table. From these it appears, that the foreign bay salt is purer, generally speaking, than salt which is prepared by the rapid evaporation of sea water; but that it is contaminated with about three times the amount of impurities discoverable in an equal weight of the Cheshire *large-grained* salt, and with more than twice that of those that are found in the *stoved* and *common* salt of the same district.

II. The *insoluble matter* in the foreign salt, after the action of boiling water, appears to be chiefly argillaceous earth coloured by oxyde of iron, and is probably derived in part from the pits in which the sea water is submitted to evaporation. We may, perhaps, assign the same origin to the very minute portion of muriate of lime, which is not found in the salt prepared by evaporating sea water in metallic vessels, nor even in the mother liquor, or uncrystallisable residue. In sea salt prepared by rapid evaporation, the insoluble portion is a mixture of carbonate of lime with carbonate of magnesia, and a fine siliceous sand; and in the salt prepared from Cheshire brine, it is almost entirely carbonate of lime. The insoluble part of the less pure pieces of rock salt is chiefly a marly earth, with some sulphate of lime. The quantity of this impurity, as it is stated in the table, is considerably below the average, which in my experiments has varied from 10 to 45 parts in 1000. Some estimate of its general proportion, when ascertained on a larger scale, may be formed from the fact that government, in levying the duties, allows 65 lb. to the bushel of rock salt, instead of 56 lb. the usual weight of a bushel of salt.

III. The *earthy muriates*, and especially that with base of magnesia, abound most in salt which is prepared by the rapid evaporation of sea water. Now since common salt, in all its forms, contains, as will afterwards appear, very little water of crystallisation, it is probable that the muriate of magnesia, discovered by the analysis of sea salt, is derived entirely from that

portion of the mother liquor which adheres to the salt after being drained, and which amounts to about one-seventh of its weight. The larger the size of the grain, the less is the quantity of this solution which the salt holds suspended; and hence the salt prepared at a lower degree of heat, being in larger crystals, is less debased by the magnesian muriate, than the salt formed at a boiling temperature. It is probable, also, that when the salt is drawn at intervals from the boiler, the proportion of the earthy muriate will vary with the period of the evaporation at which it is removed. For it may readily be conceived, that as the proportion of the earthy muriates in any brine is increased by the separation of muriate of soda, the greater will be the quantity of the muriates which the crystals of common salt, formed in the midst of the brine, will retain; thence it follows, that so far as the earthy muriates only are concerned, salt must diminish in purity as the process of evaporation advances.

According to the proportion in which the earthy muriates are present in any kind of salt, will be its power of deliquescence, or of attracting moisture from the atmosphere. It is not entirely, however, from the salts with earthy base that common salt derives this quality; for the most transparent specimens of rock salt, which I find to consist of absolutely pure muriate of soda, attract much moisture from a humid atmosphere.

IV. The *sulphate of magnesia* and the *sulphate of lime*, both enter into the composition of all the varieties of salt prepared from sea water; but the sulphate of lime alone is found in Cheshire salt. The proportion of sulphate of magnesia, is greatest in that variety of sea salt which has been formed by rapid evaporation. In foreign bay salt its quantity is very insignificant.

From the table it may be seen, that the proportion of sulphate of lime is greater in foreign bay salt than in any variety of British salt, even than in those which are prepared from sea water with a boiling heat. The only explanation of this fact, that occurs to me, is, that during the rapid evaporation of sea water, a considerable part of the calcareous sulphate is precipitated at an early stage of the process, and is partly removed in *clearing* the

boiler, a process which can scarcely be performed during the formation of bay salt, in pits whose sides are composed of moist clay. The remainder of the selenite, thus precipitated by the rapid evaporation of sea water, enters into the composition of the pan-scale.

In the course of this inquiry, I was induced to repeat the same experiments several times, on various specimens of salt bearing the same designation; and was surprised to find, that the results by no means corresponded.

It appeared that there was a gradually increasing purity in the salt from sulphate of lime, as the process of evaporation advanced, the greatest part of this earthy compound being deposited at an early stage of the process. Different specimens of the same kind of salt may, therefore, differ in chemical purity as much from each other as from other varieties. But when the impurities contained in a solution of muriate of soda, are of a different species from those of Cheshire brine, and consist chiefly of the earthy muriates, the order will be reversed, and the purest salt, as I have already suggested, will be that which is first deposited, the contamination with the muriate of lime or of magnesia continuing to increase as the process advances to a conclusion.

What then, it may be inquired, is the cause of those differences which are acknowledged, on all hands, to exist among the several species of muriate of soda, so far as respects their fitness for economical purposes? If I were to hazard an opinion, on a subject about which there must still be some uncertainty, it would be, that the differences of *chemical composition*, discovered by the preceding train of experiments, in the several varieties of culinary salt, are scarcely sufficient to account for those poperties which are imputed to them on the ground of experience. The *stoved* and *fishery* salt, for example, though differing in a very trivial degree as to the kind or proportion of their ingredients, are adapted to widely different uses. Thus the large-grained salt is peculiarly fitted for the packing of fish and other provisions, a purpose to which the small-grained salts are much less

suitable. Their different powers, then, of preserving food must depend on some mechanical property; and the only obvious one is the magnitude of the crystals, and their degree of compactness and hardness. Quickness of solution, it is well known, is pretty nearly proportional, all other circumstances being equal, to the quantity of surface exposed. And since the surfaces of cubes are as the squares of their sides, it should follow that a salt whose crystals are of a given magnitude, will dissolve four times more slowly than one whose cubes have only half the size.

That kind of salt, then, which possesses most eminently the combined properties of hardness, compactness, and perfection of crystals, will be best adapted to the purpose of packing fish and other provisions, because it will remain permanently between the different layers, or will be very gradually dissolved by the fluids that exude from the provisions; thus furnishing a slow but constant supply of saturated brine. On the other hand, for the purpose of preparing the pickle, or of *striking* the meat, which is done by immersion in a saturated solution of salt, the smaller-grained varieties answer equally well; or, on account of their greater solubility, even better.

Dr. Henry's experiments prove decisively, that in an important quality, (viz. that of specific gravity,) which is probably connected with the mechanical property of hardness and compactness of crystals, little or no difference is discoverable between the large grained salt of British, and that of foreign manufacture. If no superiority, then, be claimed for British salt as applicable to economical purposes, on account of the greater degree of chemical purity which unquestionably belongs to it, it may safely, he says, be asserted, that the larger-grained varieties are, as to their mechanical properties, fully equal to the foreign bay salt. And the period, he hopes, is not far distant, when a prejudice (for such, from the result of this investigation, it appears to him to be,) will be done away, which has long proved injurious to the in-

terests and prosperity of an important branch of British manufacture.

Dr. Henry gives a particular account of the methods of analysing the several varieties of muriate of soda, and infers that the sea water, the products of which he examined, contained no sulphate of soda, contrary to the opinion of Dr. Mitchell, of bishop Watson, and other chemical writers.

REMARKS.

In the Medical Repository of New York,* in the year 1804, notice was taken of the "Commerce of the United States with foreign parts in sea salt," in which it is stated, that the British salt that chiefly comes from Liverpool and the river Mersey, is a most pernicious article, being weak and impure: that it contained Epsom salt, Gypsum, Glauber Salt, &c. all of which injure the quality of the salt, and disqualify it for preserving animal flesh every where, but especially in hot countries and seasons.

These remarks were severely criticised by an anonymous writer in the London Monthly Magazine of June, 1804, who denied the fact of British salt being more impure than that of other countries, or of its being inferior on that account, for the purpose of preserving beef and other provision, than the salt of the Continent. He does grant, however, that although the fine salt is most proper for *striking* meat, yet that it does not preserve meat so well as the large-grained or fishery salt;—but, in reply to this remark, it is stated in a subsequent number of the Repository,† that "large parcels of pork, which were packed in the autumn of 1803, with the *large-grained* or *fishery* salt, so highly commended for its antiseptic powers, were condemned by the public inspectors as corrupt and bad, in the summer of 1804, in the New York market." The English writer refers to the experiments of Dr. Henry, to prove the purity of the British salt; and according to these, it would seem that the salt of St. Ubes, St.

* Hexade 2d, Vol. 1, p. 83. † Hexade 2d, Vol. 2, p. 213.

Martins, and Oleron, usually called Bay salt, contains more sulphate of lime, sulphate of magnesia, and more insoluble matter, and less pure *muriate of soda*, than the English salt, either fine or coarse. But Dr. Henry acknowledges, that the result of his experiments varied as the brine was taken at an early or late stage of evaporation; analysis indicating a greater degree of purity at the beginning, than toward the close of the process. After all, the fact of the capability of one kind of salt to preserve meat better than another, must be left to *experience alone*; and this most certainly is against British salt, and in favour of Bay salt. In the United States, the prejudice has always been in favour of Spanish or Portugal salt. In Holland, where the laws respecting the regulation of the "Herring Fishery," that great source of national employ and of wealth, are extremely minute, no salt is permitted to be used, *under a very heavy penalty*, except that from the countries last mentioned. Now, the uniform quality of Dutch herrings, and their preservation in all climates, are facts well known to the commercial world. In Ireland, the beef and pork for the British navy and army, which is put up at the great slaughter houses at Cork, *Bay salt* is exclusively employed; and on this account, when general Gascoigne, (the representative from Liverpool) moved in the British house of commons, in the year 1803, to equalise, by weight, the bushel, on all salt imported into Ireland, in consequence of the inequality in the duty paid on foreign salt and British salt, Mr. Corry, an Irish member, opposed the measure, on the ground that the Bay salt, although not so white as the British salt, was stronger, and on that account the use of it was *indispensable* to the salters of provisions. The house sided with Mr. Corry, and the motion was withdrawn. Bay salt is made by the spontaneous evaporation of the sea water; English salt by boiling. During the American war, salt was made in various parts of the coast by *boiling* down the sea water, and was found inadequate to the preservation of meat for any length of time. How boiling affects the quality of the salt, is explained by Dr. Henry's excellent paper.

Editor.

COTTON WOOL.

THE following is a return of the quantity of Cotton Wool imported into Great Britain for the last five years, distinguishing each year:

	Pounds.
1806	58,146,283
1807	74,925,306
1808	43,605,982
1809	92,802,282
1810	180,570,108
	406,889,956

An account of the quantity of Cotton Wool imported into Great Britain, during the last six years, and from what parts of the world imported:

	Pounds.
Europe	52,121,322
United States	207,410,922
West Indies	106,119,645
Foreign colonies	49,906,013
India	45,793,953
All other parts	4,420,306
Total,	465,772,362

ON MERINO SHEEP.

By James Caldwell, Esq.

Read to the Agricultural Society, Philadelphia.

Philadelphia, June 8, 1811.

DEAR SIR,

NOTWITHSTANDING the experience of all parts of the world, into which Merino Sheep have been imported, testifies the practicability of preserving the wool of those animals after many

succeeding generations, in other climates than that of Spain, with all the estimable qualities of the best Spanish fleeces in their highest perfection, and notwithstanding the proof of this fact, which has been exhibited to the people of America by Col. Humphreys, Mr. Livingston, and others, there are yet many persons in the United States who are deterred from purchasing Merino sheep by an apprehension that the climate of America may be less favourable to the production of fine wool than that of Spain; but as the experience of our neighbours and acquaintance has generally more influence over us than the tales of foreigners and strangers, however aided by all the power of argument in theory, I very willingly comply with your request to communicate to the society what little experience I have acquired upon this subject, from having kept a small flock of Merinos since the year 1806 to the present time. My experience has not only removed from my mind every suspicion of Merino degeneration in this climate, but has satisfied me, that with the common attention paid to well-kept flocks in this country, they will in their immediate descendants greatly excel the sheep of Spain in every desirable quality. In the year 1806, I purchased from Mr. Bulkley, in the neighbourhood of Philadelphia, one ram and two ewes, the full-blooded descendants of Col. Humphreys' Spanish Merino. But my ram died soon after, in consequence of an accidental wound, so that I had no increase to my flock that year. However in 1807, I procured from Mr. Basse a ram selected from the Prince of Hesse Cassel's flock, bought by Mr. Basse in Hesse Cassel, and brought by him to Philadelphia; by this ram, in due season, each of my Merino ewes produced a lamb, one of them a ram, and the other a ewe, both which lambs, when one year old, were superior in size to either of their parents. and at two years of age the ram lamb weighed 154 pounds, and sheered nine pounds of wool, a fair twelve months fleece, free from dirt, but not washed, having been kept constantly upon a clean sward. The ewe lamb under the same circumstances sheared 6 3-4 lbs. In about six months after their first yeaning, my two old ewes brought forth, each of them, a ram lamb, the largest of which died at Phila-

delphia, at six months old, of heat and fatigue, having been brought to this city for the purpose of exhibiting his extraordinary perfection at the annual meeting of the Philadelphia Cattle Society, This lamb was weighed the day after his death by Mr. William Hopkins, of Haddonfield, New-Jersey, and was found to weigh 95 lbs. Mr. H. also pulled from off this lamb five pounds and one quarter of wool. The other lamb of the same age, I sold to Mr. B. B. Cooper, of Gloucester county, New-Jersey, who sheared from him twelve and a half pounds of wool, his first fleece. I have since had several lambs from each of my ewes, and notwithstanding the rapidity with which they have increased their numbers, breeding every six months, I have never yet raised a ram lamb that has not sheared nine pounds of wool. I have now a ram lamb of one year old, that has sheared nine and one quarter pounds of wool this season, although a considerable quantity of his fleece had been lost in consequence of the itch or scab communicated to him by some imported sheep last autumn. This ram weighed with his fleece 130 lbs. whereas the best imported Spanish rams, very rarely weigh so much even at four years of age, and I believe no ram ever yet imported from Spain into this country, has sheared above eight pounds. Thus then it appears that the American bred Merino has acquired a superiority over the Spanish Merino in weight of carcase and quantity of wool. And whether these advantages have been obtained at the expense of a deterioration in the quality of the fleece, as to fineness of filament or otherwise, the society may have an opportunity of judging by comparing the enclosed samples taken from my youngest sheep with the best imported Spanish wool. I have met with very few imported sheep bearing wool so fine, and with none finer than the enclosed. Having no other experience to communicate at present, I will not trouble the society with any observations upon these few facts.

Dr. James Mease.

ON THE IMPROPER FORM OF BOTTLES.

From the Tradesman.

THE present form, or fashion, of common glass bottles, is to make a large cavity inwards in the bottom; the object of which, no doubt, has originally been, to make the bottle stand fair on the table, and render it less liable to be overset. But the same object could surely be obtained with a concavity not the tenth part of the usual extent, and there would also be a considerable saving in metal to the manufacturer.

It is one objection to this large and unnecessary projection in the bottom of the bottle, that it is very difficult to clean it, and it is well known, that if the bottle is not thoroughly rinsed, the liquor will be spoiled, as nothing is so easily tainted as wine, beer, porter, &c.

As this *awkward* bump in our bottles, seems to be altogether unnecessary, it is strange, that it should have been so long continued by our manufacturers, especially when they have the model of a wine decanter before them, which although it has a small degree of concavity on the outside of the bottom, has little or no convexity in the inside, and is easily rinsed. But the saving of metal alone, ought to be a sufficient inducement to make some alteration in the shape of common bottles, for the same quantity of materials that is at present required to make ten would produce twelve, if the improvement suggested were adopted.

MERINO SOCIETIES.

HAVING been favoured with a sight of the "First Report of the British Merino Society," the editor has abstracted the following account of it:

In the month of March, 1811, a numerous meeting of noblemen and gentlemen was held pursuant to public advertisement at the Freemason's tavern, London, for the purpose of forming a

society to improve and extend the Merino breed of sheep throughout the united kingdoms, it was resolved to establish the society, and Sir J. Banks was chosen president.

The first report of the committee was published in April last. It consists of the names of the officers of the society, and a list of the members with their places of residence, rules, and orders; order of proceeding at the annual and committee meetings; premiums; and a translation from the Moniteur of the 15th March last, of an able report of Montalivet, minister of the interior, to the French emperor, on the encouragement which should be granted to the multiplication of Merinos in France: this report was made by the express command of the emperor.

The annual meeting in London, and show of sheep, is to be held on the first Wednesday in March. Judges of the sheep and of wool are to be appointed the day before the meeting by the committee: their duty is pointed out by the 26th rule, which is: "The judges, in deciding on the merits of the sheep, shall consider value of fleece, symmetry of parts, and quality of flesh, *rather than the size of the animal*, and in deciding on the merits of the fleeces, they shall be governed by quantity and quality united: and in every case, they shall decline to award a premium where the merit is inadequate."

The object of the French report is, to determine upon the *best plan* to *render France* independent of other countries for wool. The minister calculates, that "in fourteen or fifteen years the improvement of sheep in France, which is proceeding as well as can be desired, will be rendered complete for ever. It remains," says he, "to lay before your majesty the means of execution, which appear to me most worthy of adoption, for settling this system on a solid and permanent basis. They consist in fixing proper stations, and adopting proper treatment as to these PRECIOUS ANIMALS, first, by establishing a large number of depots, which could supply rams to serve the ewes of private individuals; and to forbid the castration of Merino rams."

There are at present eight imperial sheep-farms in France, to which, and to the flocks of Rambouillet and Malmaison, France

is indebted for that degree of improvement in wool which has been already attained. Inspectors of rams are to be fixed at each depot, charged with distributing rams for the season, of visiting the different stations, and of attending to the health of the sheep. These inspectors must have veterinary knowledge, and be able to prescribe proper and salutary treatment; and are bound to render frequent account of the depots, and the several effects thereof, in their districts, to the prefects and minister of the interior.

By a decree of the 11th March, 1811, the emperor ordered *sixty depots* to be established, each of which is to consist of at least 150, or at most 250 rams. These rams are to be distributed gratuitously to owners of native flocks, and after using them they are to be returned to the depot. Rules are added respecting the manner of forming the depots, regulations of the police, and of general and common inspectors.

The editor will now mention, and he does it with pleasure, that a *Merino Society* has been recently formed for the middle states of the Union. Their constitution and premiums have been published, to which are prefixed some introductory observations on the origin, design, and probable advantages of the Merino society, and some of the objections against Merino flocks, subjected to the test of recent facts and present experience in the United States. They state, what is certainly the fact, that the common wool of the United States is *better* than that of Europe; that the Merinos are found with us in better plight, under the same management, than the common sheep of the country feeding foot by foot; and they show by a statement of the prices at the public sales in France, in every year from 1800 to 1810, and in England in 1806, 7, 8, that the prices of Merinos have regularly increased in proportion as the breed has multiplied; and that the demand for fine wool in both France and England, in consequence of the immense destruction of Merinos by the armies in Spain; and the daily increase of our own manufactures, allay all fear with respect to an overplus supply of fine wool.

"Let it not be deemed an unreasonable anticipation, to predicate the exportation not only of wool, hemp, and iron, but of su-

perfine broad cloth; manufactures are daily rising, which dispel all doubts on this point. The great increase of Merino stock, will contribute toward such establishments, as hitherto have been considered at a great distance, if the sales of tobacco and cotton, have become heavy, and those funds of the planter dried up, let new establishments produce more permanent streams.

"Many things require immediate attention; rules for the choice of a flock; the comparative advantages of full-blood and of mixed flocks; the proportional numbers which can be kept at the same expense: the best means of introducing and increasing the breed, full or partial blooded Merino's, among the yeomanry; the introduction of good intelligent shepherds—The discovery of the causes and means of cure of the various diseases of sheep—The improvement of the form and weight of the carcase—The best and safest mode of feeding in summer, and winter, a comparative view of the various kinds, and the expense of winter feed—The improvement of the pile and weight of the fleece. To obtain and diffuse information, on these and a vast number of other important cases, which daily experience shall invite, we hereby form ourselves into a society under the name and title of *The Merino Society of the Middle States of North America, under the following constitutional rules, and such by-laws as shall be found necessary for carrying our designs into operation.*" The following is an abstract of their constitution.

"The officers of this society shall be a president, vice-president, treasurer, secretary, and committee of correspondence; the number of which to be fixed at every election.

"The meetings of the society to be held at the houses or farms of the members, where the flocks are kept, on the first Saturday of every month throughout the year; and at every such meeting, the flock shall be inspected by the members present.

"The members of this society shall be resident and honorary. But all persons having flocks, in the states of New-Jersey, Pennsylvania, Delaware, and Maryland, shall be elected as resident members.

"Every resident member shall subscribe the constitution, and

pay into the hands of the treasurer ten dollars, and the like sum each and every year on the first Saturday of July.

"The committee of correspondence shall invite the communication of information from every quarter, upon the subjects for which the society is organized, and deliver the same to the society.

"The society shall, at their anniversary meeting, each and every year, propose such subject for competition as they shall deem worthy, to be put on the list for premiums, and at least one annual premium of fifty dollars for communications or improvements, which shall be adjudged the best, on some one of the subjects which shall have been proposed by the society for that year; the premiums shall be distributed to meritorious communications or discoveries even in cases where no competition exists; and where merit is not observed, competition shall not give a claim to the premium.

"The premiums shall from year to year be distributed indiscriminately, to such as are or are not members of the society. The claimant shall at least, however, possess one full-blooded Merino ram and ewe."

The society propose to adjudge the following premiums on the first Saturday of July, 1812.

"I. To the author of the best essay, on either, or comprehending the whole of the following subjects, *a premium of fifty dollars.*

"1st. The best rules for making choice of a flock, and the comparative advantages of the mixed and full-blooded Merino flocks.

"2nd. The cheapest and best mode of supplying summer and winter food, particularly for ewes and lambs, with estimates of the expenses of raising the food, and procuring it at market, attested by actual experiments, stating also the daily consumption of winter feed per head.

"3rd. The best means of introducing judicious shepherds.

"4th. The best means of preventing and also curing the diseases of sheep in the Middle States.

"5th. On folding, the best manner of erecting the folds and application thereof for the improvement of the farms.

"6th. The comparative advantages and disadvantages of flocks of sheep above other live stock.

"II. To the shepherd who shall have the ewes and lambs in the best plight, and under the best government, and shall have obtained the greatest proportional increase of the flock, during the preceding year. The flock shall not consist of less than one hundred ewes, all partial or full-blooded Merinos. *Fifty dollars.*

"III. To the person raising and producing the best yearling ram, the quality and quantity of the wool, the form of the carcase and live weight of the animal, are to be taken into view. *Thirty dollars.*

"IV. To the person raising and producing the best yearling ewe, under the above recommendations. *Twenty dollars.* This and the foregoing premium, shall be then adjudged, provided, at least three rams and three ewes, have been brought forward in competition, by three or more different persons.

Premiums under consideration for 1813.

"I. To the person who shall have taught any dog, a native of the United States, to perform such useful services among the flock, as those dogs which have been, or may be imported before the time when the trial shall be made. *Fifty dollars.*

"II. To the person who shall have raised green food, which shall have encreased the milk of ewes in the months of March and April, at such expense as shall render it practicable and advantageous to every farmer. Cabbage, potatoes, winter grain, oats, and burnet are excluded. *Fifty dollars.*

"III. To the person who shall have made the most satisfactory experiments, to show which of the following plants can be cultivated to the greatest advantage to the farm, and as winter feed for sheep. Turnip-rooted cabbage, turnip-cabbage, turnips, carrots, parsnips, potatoes, the experiments shall be made, on not less than three of the above roots, and not less than two acres cultivated with each particular plant. *Fifty dollars.*

"☞ The society will increase the amount or number of premiums in proportion as the funds shall come into their hands.

"In May next, the place of meeting and adjudging the premiums for 1812, will be duly advertised, in the mean time communications to be addressed to the Secretary, near Wilmington, Delaware.

"At a meeting of the Merino Society, of the middle states of North America, July 6th, 1811, the preceding articles were unanimously adopted, as the constitutional rules of the society, and the following gentlemen were elected officers for the ensuing year.

President,	JAMES CALDWELL, Haddonfield, New-Jersey.
Vice-President,	E. J. DUPONT, Brandywine.
Treasurer,	JOHN WARNER, Merchant, Philadelphia.
Secretary,	WILLIAM YOUNG, near Wilmington, Delaware.

"Twelve members were elected the committee of correspondence for the present year, viz.

His Excellency EDWARD LLOYD, Governor of Maryland.
His Excellency SIMON SNYDER, Governor of Pennsylvania.
SAMUEL INGHAM, Bucks, Pennsylvania.
JAMES MEASE, M. D. Philadelphia.
PETER BAUDUY, New Castle, Delaware.
JAMES YARD, Merchant, Philadelphia.
GEORGE LOGAN, M. D. Philadelphia Co.
RICHARD M. COOPER, New Jersey.
WILLIAM ANDERSON, Chester, Pennsylva.
WILLIAM D. PHILIPS, New-Castle, Del.
WILLIAM BUCKLEY, Lancaster, Pennsyl.
Col. ROBT. G. JOHNSON, Salem, N. J.

ON THE

PROPORTION OF WOOL TO CLOTH, FINE AND COARSE; AND ON THE EXPENSE OF MANUFACTURING CLOTH.

IN the infancy of our manufactures, facts like the following are of great importance. The first paper shows fully, that the full-blood Merino fleece grown in England, went farther in the manufacture of superfine cloth, than the prime imported Spanish wool. This single fact, was enough to disprove the positive assertions of the opposers of the improvement of the British fleece by the Merino cross, that Spanish sheep would degenerate in England, and that wool imported from Spain, or other parts of the Continent, was essential to the manufacture of British superfine cloth.

The second statement shows the different weights of wool and cloth in its progressive stages, from the raw material, to the manufactured article.

The third document comes nearer home, and shows clearly, the profit of manufacturing even coarse wool in the United States, although under increased expenses. For further facts, see Archives, Vol. 1, p. 43.

*An account of the manufacture of two pieces of navy blue broadcloth, for the premium of the society; with the report of the committee, and a letter from Dr. Parry, containing further observations on his wool.**

Particulars relating to the manufacture of two pieces of superfine navy blue cloth; one piece made from the wool grown in England, by Dr. Parry, on Merino Ryeland sheep; and the other of prime Leonesa Spanish wool, of the Coronet pile, for premium No. 5, of Class V. Manufactured by Samuel Yeats and Son, Monk's-Mill, near Wootton-under-Edge.

* Letters and papers of the Bath Society, Vol. 6.

Weight of Dr. Parry's wool, in the under-mentioned states:

Marks signifying different qualities of the wool.	Weight of each quality in the yolk, according to Dr. Parry.		Weight of ditto, received at Monk's-Mill.		Weight when scoured and dried.		Weight picked before being dried.		Weight from dyer.		Weight to picker after having been milled.		Weight of clean blue wool from picker.	
	lb.	*oz.*	*lb.*	*oz.*	*lb.*	*oz.*	*lb.*	*oz.*	*lb.*	*oz.*	*lb.*	*oz.*	*lb.*	*oz.*
R.	82	8	82	4	41	8	41	6	45	4	43	8	42	8
F.	29	0	29	8	14	6	13	14						
T.	14	0	14	4	6	10	6	6						
K.	8	8	9	0	3	14	3	10						

N. B. It must be here noted, that in scouring Dr. Parry's wool, the grease or yolk was not sufficiently got out.

By the foregoing table it will be seen that the exact weight of Dr. Parry's R wool, when dyed blue, and picked, was 42 lbs. 8 oz.

From the well-known pile of prime Leonesa Spanish wool, the Coronet, of the importation of 1805, and of which Samuel Yeats and Son bought fifty bags of Messrs. Ball, Davis, Vaughan, and Co. merchants, Bristol, at 6s. 9d. per lb. for the R, the exact weight of 42 lb. 8 oz. of picked blue wool was taken, having gone through the different states of scouring, dying and picking, the same as Dr. Parry's.

It is deemed unnecessary to detail the process of manufacture; but for the information of the committee, be it known, that the same work people were employed on both the cloths from beginning to end; that they were made with yarn of the same size, wove by the same weaver, set the same breadth in the loom; and in every part of the manufacture, the same attention and work have been given to each.

It should be mentioned, that the British wool, notwithstanding it was not so well scoured, held much better in the spinning than the Spanish.

When the two cloths were taken off the loom, there was only an apparent difference of 6 oz. of yarn in each; but in consequence of the grease left in Dr. Parry's wool in scouring, the exact weight of the stuff in the cloth made with his wool, could not be ascertained till both the cloths were scoured out of the oil used in the manufacture, dried, and weighed in the ley, after being burled, before they had gone through any process of manufacture which could waste the substance of either; which was done with great exactness, and the following is an accurate statement of the stuff in each piece of cloth.

Dr. Parry's cloth, when taken off the loom, had apparently 44 lb. 6 oz. of stuff in it; the counter piece made with the Coronet, 44 lbs. But when they were simply scoured out of the grease, the British cloth weighed only 35 lbs. 8 oz. and the Coronet, (having been more thoroughly cleaned of the yolk, when scoured in wool) weighed 38 lbs. From which it evidently appears, there were 2 lb. 14 oz. of yolk left in the British wool more than in the Spanish; so that deducting this 2 lb. 14 oz. for yolk left in the wool after scouring, Dr. Parry's cloth cannot be estimated to have more than 41 lb. 8 oz. of stuff in it off the loom, including the oil used in manufacturing; whereas the Coronet has 44 lbs.

Perhaps we cannot so fully explain to the committee, which wool manufactured best, as by giving the words of the foreman to whose superintendence the making of these two cloths was entrusted. He says, "Dr. Parry's wool and cloth in *every state*, works much more kindly than the Coronet."

Length of Dr. Parry's cloth made with 41 lb. 8 oz. of stuff—26 yards, 12 nails.

Length of the Coronet made with 44 lb. of stuff—27 yards, 6 nails.

From this statement it appears, that 41 lb. 8 oz. of British wool have made, within ten nails, as much cloth as 44 lb. of Spanish wool; but the Spanish cloth is the stoutest. They have neither of them undergone *any state* of the *press*. The colour of the wool for both the cloths was directed to be exactly the same,

but the British is darker than the Spanish. But though this may please the eye better, the darker colour will not handle so soft as the lighter shade of blue.

Although perhaps we may be deviating from our sphere in pronouncing which is the finest of the two cloths, yet we feel so fully persuaded that we are only anticipating the decision of the committee, that we do not scruple to say, that in our opinion as manufacturers, the cloth made with the British wool, and marked in Dr. Parry's name, is decidedly of the finest quality.

SAMUEL YEATS AND SON.

Particulars of the piece of cloth which obtained the Society's premium at the annual meeting, 1809.

Weight of Lord Somerville's wool in the undermentioned states, manufactured by Joyce, Yerbury, and Stoddart, viz.*

In Fleece unwashed.	Weight of each quality in the yolk.	Weight when scoured and dried.	Weight picked before being dried.	Weight from dyer.	Weight from picker.	Weight of clean blue wool.	When spun produced.	When wove.	When finished.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs. oz. skains.	yds.	yds.
22 Fl.	R. 105	46	45	46	45	45	30 8—610	36	27¼
wt. 134	F. 50	8				Oil, 4 10	Abb.		
lbs.	T. 9	4					16 1—423		
						49 10	Warp.		

The following document comes nearest home, and will clearly show the profit of manufacturing wool even under increased expense. For further facts, see Archives, vol. 1, p. 93.

AGRICULTURAL SOCIETY,

Charleston, June 29, 1807.

The following letter and statement, from a gentleman of great respectability and correctness, were laid before the society.

Gentlemen,

I HEREWITH send you the patterns of six pieces of *cloth*, manufactured in the state of Rhode Island, from South Carolina

* Letters and Papers of the Bath Society, vol. 12.

wool, which I carried with me to the northward. The wool was shorn from 65 sheep, weighing 189 1-4 lb. and valued in that state at 25 cents per lb. which when cleaned and prepared for weaving, was 137 1-4 lb.

Nos.	*Weight of Wool.*	*Sorting and picking per lb.*	*Carding and picking per lb.*	*Skains.*	*Per Skain.*	*Wove yards.*	*Per yard.*	*Milled yards.*	*Per Yard.*	*Sum Total.*	*Expense per yard.*
		cs.	cs.		cs.		cs.		cs.	D. C.	cs.
1	17	5	9½	58	4	22	11	15	25	11 2	7
2	20			50		22		16		11 32	72
3	28			65		26		22		15 2	74
4	31			72		32		24		16 96	63
5	29			60		30		23	22	15 9	68
6	11			20		14	10	10	10	14 90	45
	136			325		146		110		74 34	

189 1-4 lbs. of wool, at 25 cents, is		$ 47 31
Add expenses for manufacturing,		74 34
Freight of the wool and cloth back,		6 00
		127 65
The value of cloth returned,		142 14
Balance in my favour,		14 49

But if the whole 137 1-4 lbs. of clean wool had been manufactured into negro cloth of one quality, the same would have made 135 yards, at $ 1 30, equal to No. 4. The statement would then have been,

135 yards, $ 1 30 equal to		175 50
Deduct for manufacturing, 68 cts. per yard	91 80	
Value of the wool,	47 31	
Freight of the wool and cloth, back,	6	145 11
Balance,		30 29

No. 1—3-4 and 3-32	yard wide,	valued at	2
2—3-4 and 3-52	do.	do.	1 50
3—15-16	do.	do.	1 50
4—7-8 and 1-32	do.	do.	1 30
5—3-4 and 3-32	do.	do.	80
6—3-4 and 3-32	do.	do.	55

Their lowest value in Charleston.

The European cloths imported, and sold in Charleston at the above prices, are by no means equal to those here marked; and the wool from which they are manufactured is not of so good a quality. The South Carolina wool is admitted to be superior to English wool, and the 17 1-2 lb. of which No. 1 was made, were supposed to be next in quality, and nearly equal to the wool of Spain.

The above remarks are respectfully submitted to your society.

The Agricultural Society, upon examining the texture of the different qualities of cloth woven from the wool above marked, are fully satisfied of the correctness of the statement; and knowing that the wool on most plantations, is very little attended to in the shearing of the sheep, and saving of the wool—do recommend the serious attention of the planters to that article, and if the charges of clearing and spinning, weaving and milling, together with the freight, are saved by having them done at their plantations, it would be of infinite advantage in clothing their negroes; and that of No. 1 would answer for their own families.

Resolved, therefore, That the above be published in the newspapers, for the benefit of the planters; and that the patterns of the cloths be placed at the Courier Office for inspection.

By order of the society,

JOHN CHAMPNEYS, President.

METHOD OF MAKING LEAD VARNISH.

From the Tradesman, July, 1809.

THE method of making the lead varnish, which you inquire after, I will endeavour to describe as well as I can. I believe

the proportions are an ounce of red lead to a quart of linseed oil, but I am not quite sure, as it is a great while since I used any of it. It may be only a pint to an ounce, but experiment will ascertain that.

Take an iron ladle, and suppose two ounces of red lead and about half a pint of linseed oil, put it over the fire, stirring the materials all the time. As it grows hot towards boiling, it will grow of a browner colour; a little after that, when it comes to a proper point of heat, it will very suddenly take to bubbling, blistering, and fuming at a furious rate, and be very apt to catch fire, which may be extinguished by putting a cloth or board over it, and taking it from off the fire; after this, it will become almost black and very dingy; if you let it cool in the ladle, it will become as hard and as brittle as glass; if you then superadd the remainder of the oil, it will dissolve and mix up altogether with a moderate degree of heat, much short of boiling. You may make it more or less thick by putting less or more oil. Keep it stirring about, and now and then drop a little upon a tile, and you will judge whether the thickness be such as you like. It should be made in an iron ladle or iron pot out of doors, for it makes a most insufferable stench, and is very apt to catch fire and to boil and blister over.

ON A SUBSTITUTE FOR CANDLES.

From the Tradesman, Feb. 1809.

A VERY ingenious writer on this subject,* has strongly recommended *Argand's Lamp*,† as giving a clear saving of 15 per cent. over other lamps of the kind, in its production of a greater quantity of light for the same consumption of oil. By various experiments made with this lamp, it appears to have been a pro-

* Count Rumford.

† The superior principle of this Lamp, is the admission of a larger quantity of air to the flame, than in the common way, by having the wick of a circular form between two cylinders, the heat and light being augmented thereby, and the smoke consumed in the flame.

portion of near one to six in favour of the lamp, in point of light emitted when burning a tallow candle of six in the pound, and in producing equal light from both, the difference in point of expense, was as one to three. But for more general use, a more common lamp, having a broad wick, seems to have much the advantage, and according to the breadth it may be adjusted to give any degree of light necessary. The writer hereof, in order to make an accurate calculation of the difference between the consumption of tallow candles and that of oil, burnt for several evenings the one against the other, after trimming a common lamp as last mentioned, to give a light equal to that produced from the candles chain; the result was, that by the time a pound of candles was consumed, which cost 14*d.* only $\frac{3}{4}$ of a pint of common oil was consumed, which cost 5*d.* This was in a chamber where the lights burnt equally steady; had it been in an open shop, or where any daught of air had been, the difference would have appeared much greater in favour of the oil. It was also ascertained that a common candle, of which there were eight in the pound, or of the weight of two ounces each, would last for four hours and a quarter, or the pound would burn for thirty-four hours. It has been a strong prejudice against the the use of lamps, that they can only be used for stationary or fixed lights, as being moved by hand, they are liable either to go out or spill the oil; to prevent this inconvenience, I would recommend, that a common tin hand-lamp be used, made after the construction of the marine compass, always to keep its equilibrium, which requires nothing more than having the body of the lamp suspended on a pivot within a double hoop, forming the stand, when being moved in any manner the flame will always be uppermost, and the oil never spill.

Time also may render further improvement in the invention of gas lights; however, it does not appear they can be ever rendered practicable but in extensive manufactories, and the adoption thereof would be of essential service to the coal trade. In Manchester this has been carried into effect on an extensive scale, particularly in the cotton mills, warehouses, and even the

dwelling-house of Messrs. Phillips and Lee. In ascertaining the quantity of light used during the hours of burning, it appears to be equal to that of 2500 mould candles of six to the pound. The burners, 271 in number, are after the principle of Argand's Lamp, each giving a light equal to four candles, and 633 common burners from small conical tubes, having three small circular apertures through which the gas issues; each of these burners giving lights equal to two candles and a quarter. These 904 burners require an hourly supply of 1250 cubic feet of gas, from cannel coal, as being of superior quality for that purpose, notwithstanding its high price. This manufactory is computed to require the lights two hours in every twenty-four during the year, and the consumption of coals for each two hours is 7*d.* of cannel coal, and about one-third the quantity of common coal. The annual consumption of cannel coal will be 110 tons, and its cost 125*l.*; and of the common coal 40 tons, and cost 20*l.* After this the coak produced will be 70 tons, value 93*l.* exclusive of a production of 1250 gallons per annum. The interest of the capital expended in erecting the proper apparatus, will be about 55*0l.* per annum, making the whole expenses of lighting per annum 602*l.* The expense of candles to give the same light, reckoning them at 1*s.* per pound, would be 2000*l.* Since the first erection of this apparatus, the original inconveniences from the smell of the gas has been completely obviated, and Mr. Lee's house is brilliantly illuminated therewith to the exclusion of every other species of artificial light. The same plan has also long been carried into effect very successfully throughout the extensive premises of Messrs. Boulton and Watt, at Soho. As it is entirely free from danger of sparks, and the frequent snuffing of candles, or trimming of lamps, it is of the utmost importance in diminishing the hazard by fire.